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(Including the WAVES AND ELECTRONS Section)

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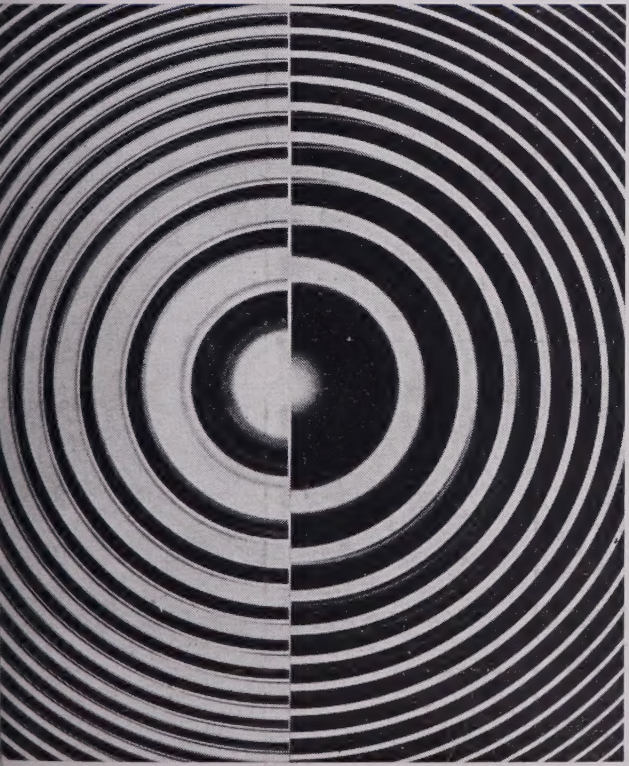

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Digital Computer for Scientific Applications
Signal-to-Noise Ratio in AM Receivers
Rectification of Sinusoidally Modulated Carrier in the Presence of Noise
Ray Path and Wave Absorption in a Deviating Ionosphere Layer
Negative-Ion-Blemish Elimination
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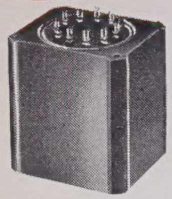
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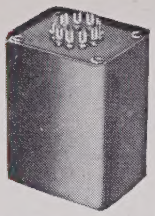
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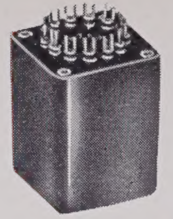
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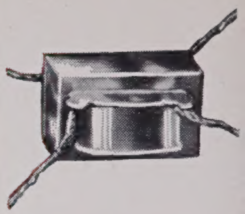
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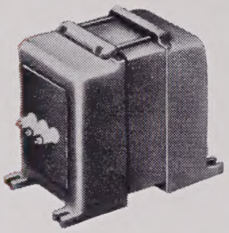
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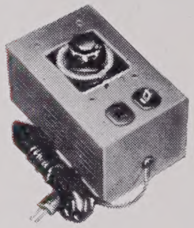
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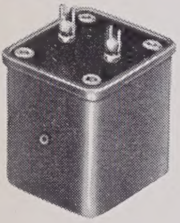
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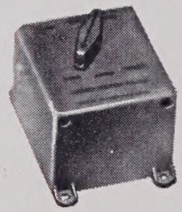
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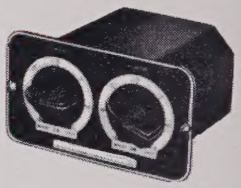
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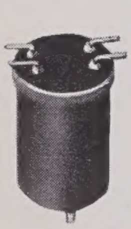
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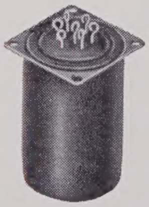
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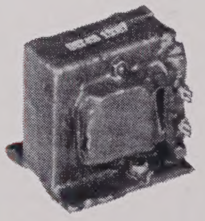
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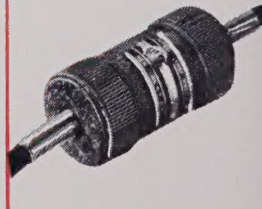
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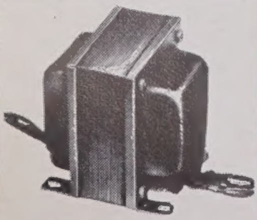
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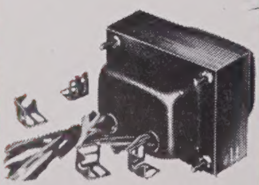
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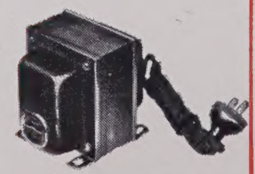
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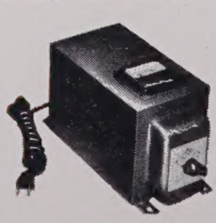
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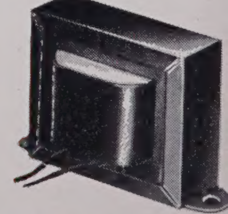
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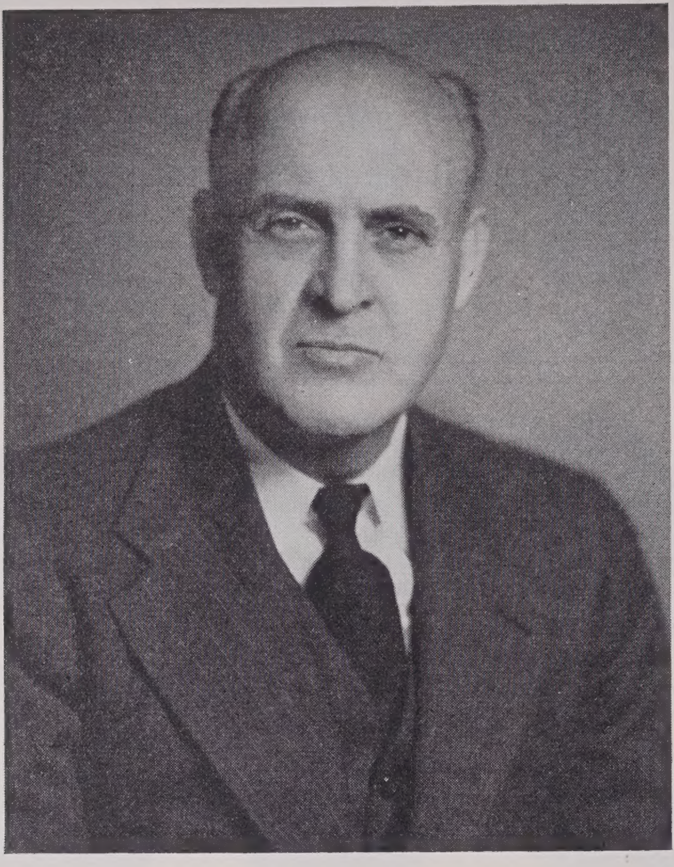

Frederic Stanley Howes

DIRECTOR, 1948

Frederic Stanley Howes, associate professor of electrical engineering at McGill University in Montreal, was born on July 25, 1896, at Paris, Ont., Canada. Graduating from high school in 1916, he immediately enlisted in the Canadian Army and served as a signaller until his discharge at the end of the First World War. He thereupon entered industry and worked as a sheet-metal layout man until 1920, when he matriculated at McGill University in order to complete his interrupted studies.

In 1924 Mr. Howes received the B.Sc. degree from McGill and was then appointed an instructor there. He continued in that post until 1927, having been awarded the M.Sc. degree the year before. His graduate work was finished in England where the City and Guilds Institute, Imperial College, University of London, gave him the doctorate in electrical communication engineering following a two-year period of study there.

Immediately afterward, in 1929, Mr. Howes rejoined McGill as an instructor and has taught there since with but one interruption—after becoming an Associate of the IRE in 1937, he spent the following year, 1938–1939, in studying advanced communication engineering at the University of California in Berkeley, U. S. A.

In 1940, shortly after Canada entered the War, Dr. Howes was appointed a civilian instructor at the RCAF's No. 1 Wireless School at McGill. Meanwhile, during the summers of 1941 and 1942 he di war development work at the Northern Electric Company in Montreal. In 1942 he organized graduate evening courses in communication engineering at McGill. The year 1943 heralded Dr. Howes appointment to an assistant professorship; his opening of a privat consulting practice as a radio engineer specializing in broadcas antenna design and related problems; and his being transferred t the rank of IRE Member and advancement to Senior Member.

Dr. Howes became an associate professor in 1946. Currently, i addition to his lecture work, he is in charge of the radio engineerin laboratories at the University and is supervisor of graduate evenin classes at McGill and Ottawa both.

Elected Chairman of the Montreal Section for the year 1945 Dr. Howes was also appointed Chairman of the IRE Canadian Council, a position which he still holds. He is the Canadian IRE representative on the administrative board of the Canadian Radi Technical Planning Board and also represents the IRE on th Canadian Council of Professional Engineers and Scientists. Chairma of the latter organization, which is composed of the Presidents o eleven national engineering and scientific organizations, Dr. Howe also is a member of the Council of the Corporation of Professiona Engineers of Quebec.

There has been a wealth of sometimes heated argument as to the relative opportunities for engineers in private versus governmental employ. One side of this question is clearly and forcefully presented, with substantiating reasons, by the writer of the following guest editorial—a member of the IRE Board of Editors and a skilled communications engineer who, after seventeen years of experience in private industry, has joined the staff of the Sandia Base Branch of the Los Alamos Scientific Laboratory.—*The Editor.*

Are You Satisfied?

C. W. CARNAHAN

To those radio engineers who are happy in their present work, this editorial can have little interest. It is addressed primarily to those who had real jobs to do during the war, and who now find their return to peacetime pursuits something of a let-down.

This group will remember that their war labors, while long and arduous, were vital and exciting, and that they demanded the utmost of their skill and knowledge. Things were built in the way they should be built, neglected text books had to be dug into again, and sudden accretions of knowledge in entirely new fields had to be gained. Results were measured in terms of lives and victories, not in figures on a quarterly statement.

Since the end of the war, however, many engineers have returned to their prewar occupations, where their technical achievements now may consist of such exciting things as saving ten cents on that new receiver, or making a further compromise with quality to beat that other outfit. They have returned to the normal battle with the sales department, whose decisions and salaries invariably outrank their own. Many of them look back with longing to the days when vice-presidents made fair expediters, and sales departments, while drawing those fat salaries, of course, at least had to listen to the engineers without any backtalk. In their leisure, they now read in the PROCEEDINGS about a rapidly expanding art which is growing beyond them.

Continued government spending in the postwar period has already had a considerable effect in those radio industries which existed before the war. The unfilled demand for engineers in government work has made more valuable commodities out of those still in private industry. This point management usually concedes with reluctance, being prone to indicate to dissatisfied engineers the horrors of governmental work, the insecurity, the red tape, bureaucracy, restriction of publications, and so forth. Those old timers who remember the security and other advantages offered by private industry in the thirties will be able to assess these arguments at their true worth.

Financially, the average engineer will not be any more underpaid in government work than he is in private industry. As for job security, there are more problems now than there are men to solve them, and new ones arise every day Furthermore, the advances in knowledge and new techniques resulting from this work will create new jobs in private industry for those who can fill them. There are publication restrictions, of course, but to compensate there are interesting, demanding work on the frontiers of radio knowledge, unlimited facilities to work with, and no sales department on the engineer's neck. What more can a good engineer want?

So far, this has been an appeal to the self-interest of the individual engineer. There is, however, a larger side to this. Good men must be found for the unfilled government jobs now available, if our stated objectives of national security are to be attained. If a fair percentage of those who performed so splendidly during the war will take up where they left off, this need will be met.

A Digital Computer for Scientific Applications*

C. F. WEST†, MEMBER, IRE, AND J. E. DeTURK†

Summary—**During the past two years development has been initiated on several large-scale automatic digital computing machines, both in this country and abroad. The present paper is concerned with the over-all organization of one such machine. A logical division of the machine into four major components is described, and the machine performance is interpreted in terms of these component functions. The electronic techniques used to accomplish the storage, transmission, and arithmetic manipulation of numbers, together with certain methods used for control of the computer, are briefly discussed. Although the paper is concerned with the design of a particular machine, it is felt that the design problems and engineering techniques are applicable to most large-scale computing machines.**

I. INTRODUCTION

THE TERM "digital computer" applies to a calculating machine in which a number can assume only a discrete value the precision of which is determined by the number of digits used for its representation. A desk calculator is a digital (or discrete-variable) computer, whereas a slide rule is a continuous-variable computer. A large-scale digital computer is a machine not only capable of digital computation, but one which can perform long sequences of computations in accordance with a pre-established program of operation. Machines of this type are also referred to as sequence-controlled calculators. Such a computer is capable of solving complex problems involving thousands or millions of individual arithmetic operations without the intervention of a human operator.

Large-scale computers may be divided roughly into two categories: Scientific machines which are designed to perform large numbers of calculations based upon relatively few input data and yielding relatively few output data, and statistical machines of which the opposite is true. The calculator to be described is intended primarily for scientific applications. Some of the types of problems which the present machine is intended to solve are the following:

1. The systematic handling of linear arrays.
2. Solution of the partial differential equations of hydrodynamics.
3. Fourier analysis and synthesis.
4. Applications of electromagnetic theory.
5. Study of shock waves.
6. The solution of nonlinear differential equations.
7. The problem of systematic sorting.

The only true computing operations which the machine can perform are the basic arithmetic operations of addition, subtraction, multiplication, and division. Before the above complex problems can be presented to the machine for solution, they must be reduced to arithmetic processes through application of the methods of numerical analysis. These arithmetic routines must then be expressed in terms of coded commands which the machine is capable of following.

II. MACHINE ORGANIZATION

Fig. 1 is a block diagram showing the principal components of a large-scale digital computer. The arithmetic unit is the only true computing unit in the machine. That is, it is the only one capable of generating new numbers. The internal (or high-speed) memory is a storage place for numbers and commands. During computation, numbers which serve as operands are transferred from the internal memory to the arithmetic unit where the arithmetic operations take place. The result of each arithmetic operation is returned to the internal memory. The central control unit of the machine governs the exchange of numbers between the interna memory and the arithmetic unit. Central control governs this exchange in accordance with orders or commands which are also located in the internal memory For each arithmetic operation, the central control must select two operands from the internal memory, and must supply these to the arithmetic unit. It must designate to the arithmetic unit which operation (e.g., addition division) is to be performed, and must transfer the result of the operation to a selected memory position. Centra

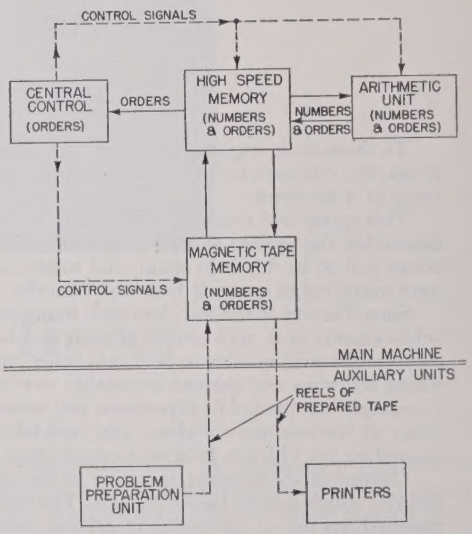

Fig. 1—Block diagram of the digital computer.

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* Decimal classification: 621.375.2. Original manuscript received by the Institute, May 19, 1948. Presented, 1948 IRE National Convention, New York, N. Y., March 25, 1948.

This paper describes preliminary computer design studies conducted for the National Bureau of Standards under Contract CST 8092.

† Raytheon Manufacturing Company, Waltham, Mass.

control then initiates the next operation by selecting from the internal memory the next command.

The magnetic memory units are used to supplement the internal memory. These units store numbers and orders on magnetic tape. The speed of operation of the magnetic units is considerably less than that of the internal memory, but the storage capacity is many times greater. These units also serve as input-output devices for the computer.

The page printers and problem-preparation unit shown in Fig. 1 are auxiliary units which are not directly connected to the main part of the machine, but which communicate with the computer by means of the magnetic memory units. The problem-preparation unit consists of a manually operated keyboard which is used to record initial numbers and commands on magnetic tape. This device makes use of additional magnetic storage containing the commands for frequently used computing routines. Thus, certain complete routines may be introduced into the computer by a single manual operation. The page printers are electrically operated typewriters which respond to signals recorded on magnetic tape. They are used to record the final results of computation.

Because one command is required for each arithmetic operation, it might seem that a prohibitive number of commands would have to be introduced into the machine in order to direct the solution of a relatively simple problem. This is not the case. The iterative methods of numerical analysis involve the repeated performance of computing routines. When a routine is repeated, the commands governing the computation may differ from those of the previous cycle only with respect to some systematic pattern of variation. By storing commands in the internal memory and by the use of suitable schemes for their coding, they may be introduced into the arithmetic unit and modified by addition or subtraction. As an example of the effectiveness of this process, the total number of commands which must be supplied to the machine to obtain all of the roots of a polynomial equation should not exceed fifteen. This number is independent of the degree of the polynomial.

The complexity of the problems which a machine can solve efficiently is limited both by computation speed and memory capacity. For example, partial differential equations in three dimensions and time may require a total storage of 10^6 numbers and may involve 10^{10} arithmetic operations. In the present machine, the internal memory has a capacity of approximately 4000 numbers, and the permanent storage medium associated with each magnetic memory unit has a capacity of 200,000 numbers. The over-all speed of the computer depends primarily upon the time required to perform the basic arithmetic operations and the time required to select a number from the internal memory. In this machine, 900 arithmetic operations together with the associated memory selections are performed each second.

Since the entire function of the machine is to carry out numerical computation in accordance with coded commands, the representations of numbers and commands are basic elements of the machine design. Numbers may be represented in a variety of ways, depending upon both the mathematical and the physical means employed.

Mathematical representations may employ different number bases. Thus an n-digit decimal number (base ten), as conventionally written, is a shorthand expression for the quantity.

$$A_n \cdot 10^n + A_{n-1} \cdot 10^{n-1} + \cdots + A_j \cdot 10^j + \cdots + A_0 \cdot 10^0 \quad (1)$$

where the integer coefficients A_j are the digits of the number. Any A_j in the decimal system may take on a value from 0 through 9. When a number is represented to the base X, it is still written as a sequence of digits A_j, but these now are interpreted as meaning

$$A_n \cdot X^n + A_{n-1} \cdot X^{n-1} + \cdots + A_j \cdot X^j + \cdots + A_0 \cdot X^0 \quad (2)$$

and any digit A_j can now take on only the values 0 through $X-1$.

In addition to the decimal notation, this paper will refer to the binary scale of notation; i.e., $X=2$ in (2) above. Here the only possible digits are 0 and 1. The binary equivalents of the decimal numbers 0 through 15 are shown in Table I.

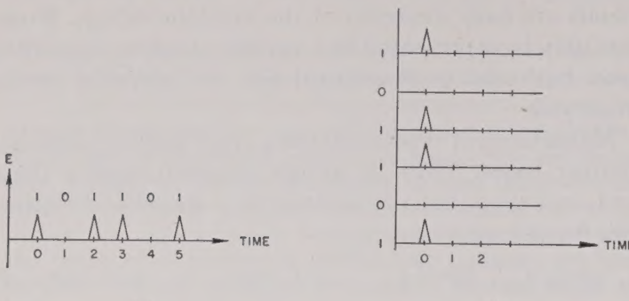
TABLE I

DECIMAL BINARY EQUIVALENTS

Decimal	Binary	Decimal	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	10	1010
3	0011	11	1011
4	0100	12	1100
5	0101	13	1101
6	0110	14	1110
7	0111	15	1111

The physical representation of a number to the base X requires a physical representation for each of the possible digits (0 through $X-1$) in each of the n-digit columns. That is, each number is denoted by a particular selection from X^n physical states. For a given number base, several physical representations are possible, depending upon the number of temporal and spatial selections used to designate the number. Fig. 2 shows two ways in which the binary number 101101 may be represented. At (a) the number is being transmitted serially on a single wire and the representation is entirely temporal. At (b) the number is being transmitted in parallel on six wires and the representation is entirely spatial. In either case, the digit 1 is represented by the presence of a pulse, and the digit 0 by the absence of a pulse.

Because the rules of arithmetic are simpler in the binary notation than in any other base, this notation is used in the present machine. Binary-decimal conversion is required at the input and output of the machine.



(a) (b)

Fig. 2—Serial and parallel representation of the number 101101. (a) Serial transmission on one wire. (b) Parallel transmission on six wires.

This may be justified in a calculator for scientific problems because of the large amounts of calculation that are done with comparatively few initial data.

When discussing machine operation, it is convenient to speak of a composite pulse group of fixed length as a "word." A word in the present machine contains 45 pulse positions or binary digits which are transmitted between units in a serial manner. Two kinds of words are shown in Fig. 3. These are: (1) a "number word,"

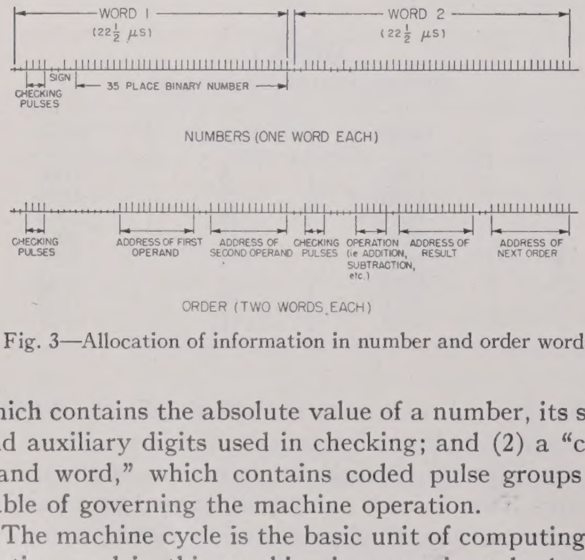


Fig. 3—Allocation of information in number and order words.

which contains the absolute value of a number, its sign, and auxiliary digits used in checking; and (2) a "command word," which contains coded pulse groups capable of governing the machine operation.

The machine cycle is the basic unit of computing operation, and in this machine is approximately 1 millisecond in duration. During this cycle four distinct events take place. (1) Two operands are selected from the internal memory and are sent to the arithmetic unit. (2) The arithmetic unit performs the desired operation. (3) The result of the operation is sent back to the internal memory. (4) The command which governs the next operation is selected from the memory.

A command is required for each machine cycle and contains all the information necessary for the performance of the cycle, namely, the locations of the operands, the specification of the operation, the location which is to receive the result, and the location of the next command. Locations within the memory are termed addresses, and are specified by binary numbers which identify consecutively all of the storage positions of the memory. Operations are also specified by coded pulse groups.

Besides addition, subtraction, etc., several nonarithmetic operations are required during the solution of most problems. The transfer operation serves to transfer a word between different memory locations, or between the internal memory and one of the magnetic memory units. The substitution operation is used to modify a command word by adding or subtracting from one or more of the addresses contained within the command.

The branch operation allows the machine to choose between two computing routines on the basis of the results of past computation. The command governing the branch operation contains the locations of two commands, only one of which is to be chosen to govern the next computing cycle. This choice is determined by the sign of the inequality of the two operands. As an example of the use of the branch operation, consider the solution of a polynomial equation. An approximate root of the equation is calculated by means of computing routine A. The difference between this approximation and the last approximation is obtained. If this difference is greater than some preassigned number, the next command selected is the first command of routine A, and its selection results in the calculation of a nearer approximation. If the difference is less than the pre-established tolerance, the next command selected is the initial command of routine B, which initiates reduction of the degree of the polynomial in preparation for the calculation of the next root.

III. Internal Memory

The internal memory must be capable of storing a large number of words with short access time. The stored information must be easily erasible. In the present machine, the internal memory makes use of the acoustic delay line as the storage mechanism. Fig. 4 is a block diagram of an acoustic delay line in which mercury is the acoustic medium. Assume that the line contains some pulse configuration at a given instant of time, and that the configuration is propagating down the line at the velocity of sound in mercury. Each pulse received at the output transducer is amplified and

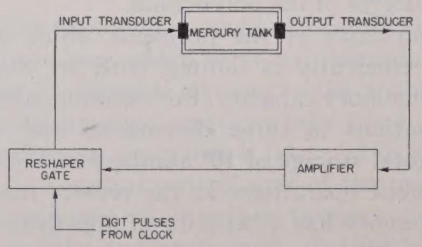


Fig. 4—Delay-line memory unit.

applied to a gate or reshaper which allows a new digit pulse from a continuous pulse source to be fed to the input transducer. Thus, the pulse configuration will circulate around the closed loop indefinitely without progressive degeneration of the pulse shapes or the pulse spacing.

The number of pulse positions which a line contains (i.e., its storage capacity) is proportional to the time delay of the line and the frequency of the continuous pulse source. The former is limited by the attenuation of the mercury and the transducers; the latter, by the bandwidth which can be attained around the circulation path and the dependence of attenuation on frequency.

The access time of the delay line is equal to the delay time. For a given memory capacity, the access time may be decreased by decreasing the length of each line and increasing the total number of lines while the repetition rate is held constant. Reduction obtained in this manner is costly, for the total memory equipment is primarily proportional to the number of circulation paths and is only secondarily influenced by the attenuation per path. The access time can be reduced more effectively by increasing the pulse-repetition rate and shortening the line, while holding constant the number of lines and the pulse capacity of each.

The present machine design makes use of 255 acoustic delay lines, each capable of storing 16 information words and one additional word used for checking. The total memory capacity is, therefore, 4080 words. The delay lines operate at a pulse-repetition rate of 2 Mc, and the digit pulses are amplitude-modulated upon a 30-Mc carrier. The memory access time is about 380 microseconds.

Fig. 5 is a block diagram of a delay line showing the use of additional gates for reading (i.e., taking information from the line), writing (i.e., putting information into the line), and erasing. The erase gate and the write gate are normally connected together, so that a word is erased only when a new word is written into the line.

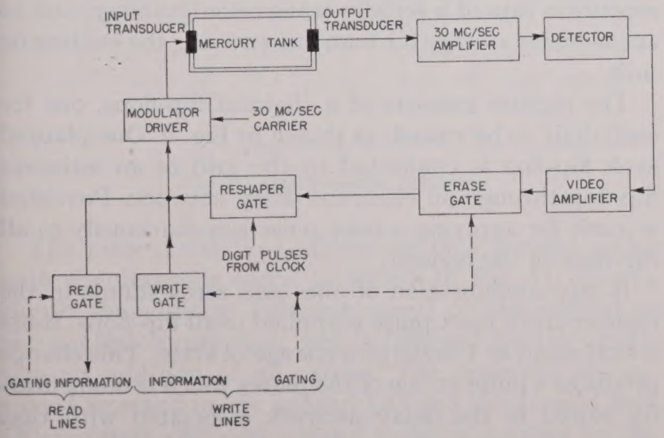


Fig. 5—Organization of memory-delay-line circuits.

Continuous circulation through a delay line requires that the delay time be a constant integral multiple of the period of the continuous pulse source used for reshaping. Because the acoustic velocity in mercury is temperature-dependent, some means of temperature control is required. The temperature coefficient of acoustic velocity is such that a 1 per cent change in delay time results from a temperature change of 30°C. The temperature effect may be expressed more conveniently by the equation

$$\Delta T = \frac{3000\eta}{N}\,{}^{\circ}\mathrm{C}. \tag{3}$$

where ΔT is the permissible temperature variation in degrees centigrade, N is the total number of pulse positions in the line, and η is the fraction of a pulse period by which the delay can change and still allow reshaping of the circulating pulses. By using sharp pulses in the reshaping operation, the value of η may be made as high as 0.75 without difficulty. In the present design, each delay line contains 765 pulses, and the corresponding permissible temperature gradient is approximately 3°C.

Temperature gradients in the memory can be controlled, while reasonable equipment accessibility is maintained by subdividing the memory into groups of lines. Each group may consist of several (say, 6 to 10) independent acoustic paths operating within a single container of mercury. The relatively high thermal conductivity of mercury is effective in keeping the gradients between paths small. Each container is then supplied with an independent temperature-control mechanism which maintains the temperature of the pool constant.

Fig. 6 is a photograph of a mercury pool contained in a stainless-steel tank less than 7 inches long, $2\frac{1}{4}$ inches high, and $2\frac{1}{4}$ inches wide. Three acoustic paths operate within the pool. Each path is multiple-reflecting and consists of three travels the length of the container. The circulation time of each path is 320 microseconds. This pool has been used in a prototype memory unit

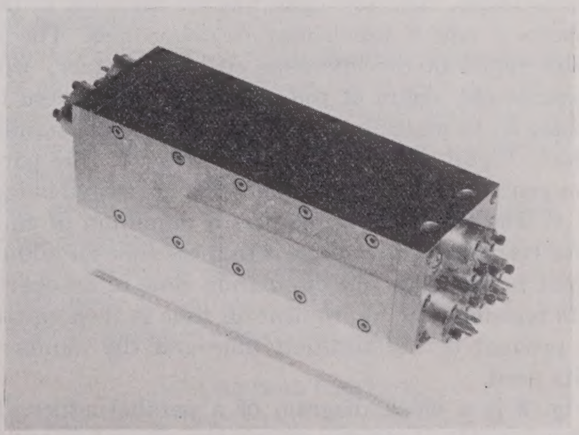


Fig. 6—Photograph of a mercury pool contained in a stainless-steel tank, with three acoustic paths operating within the pool.

with temperature control used to maintain synchronization between the delay line and a fixed-frequency pulse source.

IV. ARITHMETIC UNIT

The basic arithmetic operation is addition. Other arithmetic operations, though coded as single operations, are compounded of successive additions performed under the local control of the arithmetic unit. Accordingly, the mechanism of addition largely determines the manner in which other operations are carried out. Addition may be performed serially or in parallel. In a serial adder the two operands are added one digit at a time, commencing with the lowest-order digit. In a parallel adder, all of the digits of one operand are simultaneously added to the digits of the other operand, thereby generating all the digits of the sum at once.

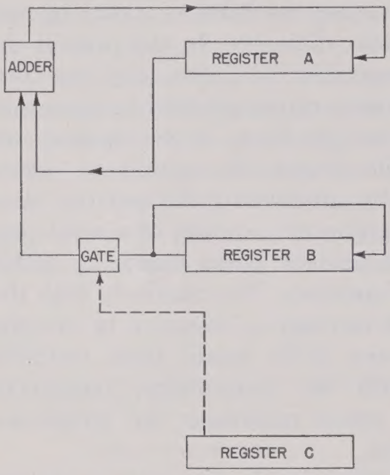


Fig. 7—Serial-adder operation.

Fig. 7 is a block diagram indicating the operation of a serial adder. The two operands are assumed to be in registers *A* and *B* which may be delay lines. The successive digits of the operands enter the adder, which generates the digits of the sum and enters these into register *A*. In multiplication, the multiplicand stands in register *B* and the multiplier in register *C*. The partial sums generated during multiplication are stored in register *A*. The serial adder requires a minimum of equipment. Its chief disadvantage is that the time for addition cannot be less than the circulation time of an operand in its register. The multiplication time is then equal to the product of the addition time and the number of digits used.

Fig. 8 is a block diagram of a parallel adder. The addend stands in register *A* and the augend in register *B*. Upon application of a control pulse, all columns of the addend are simultaneously added to the augend and the sum is left standing in the sum-augend register. In principle, the addition is completed in one pulse time, although practical considerations generally require that the process take from 5 to 10 pulse times.

Speed is obtained at the expense of equipment in the parallel adder, for the basic columnar adding circuit must be repeated for each digit column of the addend and augend. A further advantage of the parallel over the serial adder is that the parallel unit requires less complex control circuits to perform operations compounded of repeated additions.

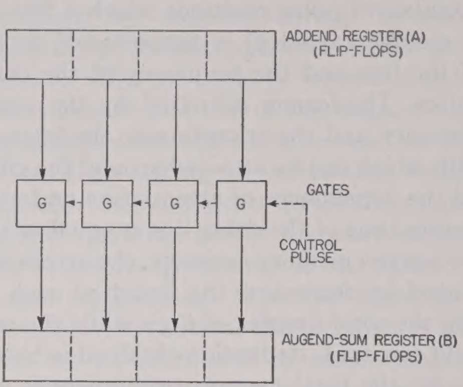


Fig. 8—Parallel-adder operation.

With either type of adder several variations are possible, depending upon the method used to transfer carries from one column to another. For example, a parallel adder may first perform the addition without carries and later add the carries to the result. The addition of carries may generate new carries which must be added in again. Such sequential adding of carries increases the time required for an addition. Simultaneous addition of carries may be performed by adding all carries to the augend in one operation. In this case, the addition speed is limited only by the propagation times of the carry pulses and the add pulses through the necessary circuits.

Before discussing the adder circuits in detail, it is worth while to describe a shift register. This is a simpler device than the parallel adder, but involves similar techniques. The register may be used to convert between serial and parallel number representation, to change the repetition rate of a serially transmitted number, and to act as buffer storage for numbers entering the arithmetic unit.

The register consists of a chain of flip-flops, one for each digit to be stored, as shown in Fig. 9. One plate of each flip-flop is connected to the grid of an adjacent flip-flop through an electrical delay network. Provision is made for applying a reset pulse simultaneously to all flip-flops in the register.

If any configuration of ones and zeros stands in the register and a reset pulse is applied to all flip-flops, those which stand at 1 undergo a change of state. This change produces a pulse at one of the plates which is momentarily stored in the delay network associated with that plate. After the reset pulse has passed, every pulse which entered a delay network emerges and triggers the flip-flop immediately to the right of it. In this manner the configuration of ones and zeros is shifted one column to the right.

In Fig. 9 a three-digit word is shown serially entering the shift register. A train of reset pulses is applied to the shift register at the same repetition rate as the digits of the entering word. The reset pulses must be advanced, with respect to the applied digit pulses, to avoid interference between the two pulse trains. Once the word stands in the register it may be read out in parallel from the plates of the flip-flops, or it may be read out serially at some other repetition rate by applying reset pulses of the desired frequency. Fig. 10 is a circuit diagram of two columns of a shift register which operate reliably at pulse rates up to 2 Mc.

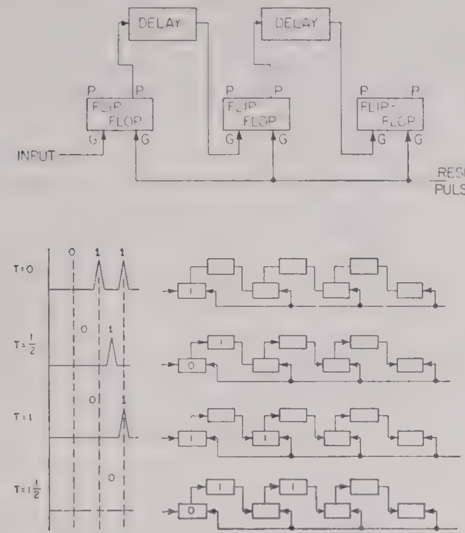

DELAY
DELAY
P
FLIP FLOP
G
INPUT
RESET PULSES
T=0
T=1/2
T=1
T=1 1/2
0
1

Fig. 9—Shift-register operation.

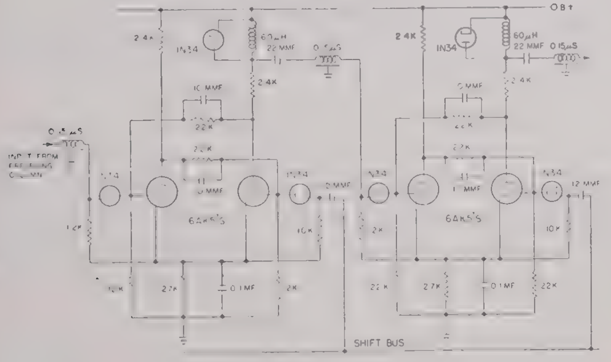

OB+
2.4K
1N34
60μH
22 MMF
0.15μS
2.4K
10 MMF
22K
INPUT FROM PRECEDING COLUMN
6AK5'S
10K
27K
0.1MF
22K
12 MMF
SHIFT BUS

Fig. 10—Shift-register column.

The present machine makes use of a parallel adder with simultaneous carry, as shown in Fig. 11. In this circuit the addition (without carry) of the addend to the augend occurs first, and is followed by the simultaneous addition of all carries. The operands are assumed to stand in the addend (A) and the augend-sum (B) registers. An add control pulse is applied to the gates *G1*. In each column where the addend contains a 1, the control pulse passes through the normally closed gate *G1* and changes the state of the corresponding column of the augend-sum register. Following the addition without carry, a carry pulse is applied to the normally closed gates *G2*. Gates *G4* sense the digits standing in the A and B registers. In each column where a 1 stands in the addend register and a zero in the augend-sum register, gate *G4* opens gate *G2*. The applied carry pulse passes through *G2* to an electrical delay network, as well as to gate *G3*, through the phase inverter *I*. Gate *G3* is open if a 1 stands in the augend-sum register, and the carry pulse passes *G3* to the next higher-order column, etc. Thus, a carry pulse which is initiated in any column may pass several gates *G3* and be applied to several higher-order columns. Each time a carry pulse passes a gate *G3*, it is applied to the electrical delay network associated with the next column. The propagation of the carry pulses does not immediately cause a change of state in any of the flip-flops, but rather serves to introduce the carry pulses into the appropriate electrical delay networks in accordance with the configurations of the numbers in the A and B registers. After propagation of the carry pulse, all pulses applied to the delay networks emerge and change the states of the associated augend-sum flip-flops. The true sum then stands in the lower register.

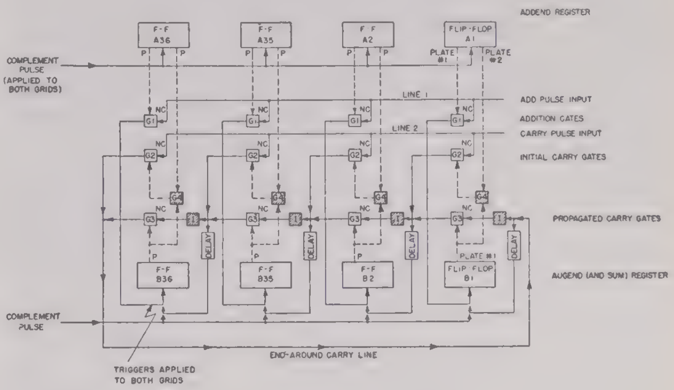

ADDEND REGISTER
F-F A36
F-F A35
F-F A2
FLIP-FLOP A1
PLATE #1
PLATE #2
COMPLEMENT PULSE (APPLIED TO BOTH GRIDS)
LINE 1
LINE 2
ADD PULSE INPUT
ADDITION GATES
CARRY PULSE INPUT
INITIAL CARRY GATES
NC
G1
G2
G3
G4
I
DELAY
PROPAGATED CARRY GATES
P
F-F B36
F-F B35
F-F B2
FLIP-FLOP B1
AUGEND (AND SUM) REGISTER
COMPLEMENT PULSE
END-AROUND CARRY LINE
TRIGGERS APPLIED TO BOTH GRIDS

Fig. 11—Parallel adder employing simultaneous carry.

Numbers may be placed in the adder registers by the use of shift-register techniques, in which case additional gates and delay circuits are associated with the register flip-flops so that these may function as a shift register during the introduction of a number.

The arithmetic unit of the computer requires numerous control circuits in addition to the basic adder. These are necessary to perform the compound arithmetic operations of multiplication and division, as well as the logical operations described previously.

V. Central Control

The basic cycle of machine operation requires supervision of the following processes: selection of the operands from the memory, specification of the operation to be performed, disposition of the result, and the selection from memory of the next command. Many possible organizations of the central control unit exist, depending upon the time and manner in which the above steps are carried out. For example: (1) the selection of the two operands may occur sequentially or simultaneously; (2) the selection of operands may occur while previous operands are being processed in the arithmetic unit, or after the arithmetic process has been completed; (3) the disposition of a result may or may not occur simultaneously with some of the other steps; (4) part of or all of a command may be selected in one step; (5) a command may be selected in accordance with information contained in the previous command, or all commands may be located consecutively in the memory; (6) the control sequence may constitute a fixed cycle in which each step or combination of steps is allocated a fixed amount of time, or a variable cycle in which each step proceeds as soon as the previous step has been completed. There is no known optimum organizational pattern for the control process. Compromises must be made between speed of operation, simplicity of operation, and economy of equipment. By performing a large number of steps in parallel, the speed, cost, and complexity of the machine are all increased.

The control system of the present machine involves fixed-cycle, dual-selection operation. Each command is selected on the basis of information contained within the previous command.

A command consists of two words which are stored in adjacent positions in the internal memory. Referring to Fig. 3, it will be seen that each word of a command contains two address positions and a group of checking pulses. The second command word also contains an operation code. For most operations, address positions 1 and 2 contain the addresses of the two operands, address position 3 contains the address of the result, and address position 4 contains the address of the next command. Two exceptions to the above occur: (1) Certain operations (e.g., transfer) require but one operand. This appears in the first position, and the second position is then vacant. (2) In the branch operation the addresses of two commands appear in the third and fourth positions. The branch operation chooses which of the commands will be used in the next computing cycle.

The fixed-operation cycle is called the machine cycle, and is approximately 1 millisecond in duration. It is composed of three equal parts called major cycles which are equal in duration to the circulation time of a memory delay line, and which are synchronous with the memory circulation. During the first major cycle, the command governing the cycle is selected from the memory, and simultaneously the result of the previous computation is transferred to the memory. The selections made at this time are governed by the third and fourth addresses of the previous command. During the second major cycle, the two operands specified by the new command are selected from the memory, and the operation code is transmitted to the arithmetic unit. During the third major cycle, the arithmetic operation occurs.

From the above discussion it is apparent that the central control unit must contain registers for storing a complete command, and two selection circuits for the simultaneous selection of two memory locations. Since the operands selected from the memory may arrive at central control during any part of the selection cycle, the central control should also have one-word storage registers for holding the operands until they are to be transmitted to the arithmetic unit. A one-word register for the result is also required. The simplified organization of the central control is shown in Fig. 12.

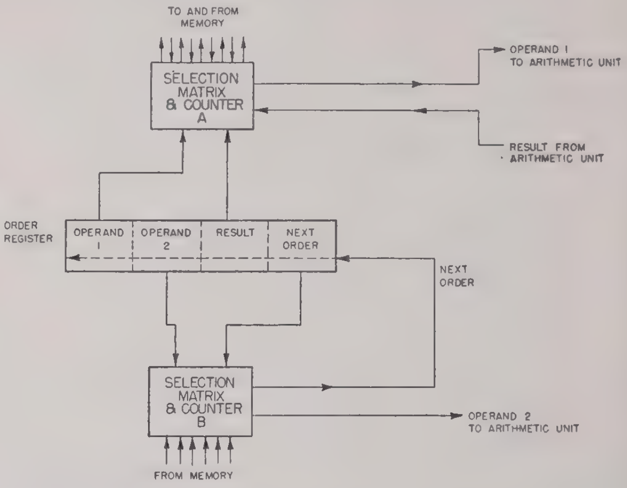

TO AND FROM MEMORY
SELECTION MATRIX & COUNTER A
OPERAND 1 TO ARITHMETIC UNIT
RESULT FROM ARITHMETIC UNIT
ORDER REGISTER
OPERAND 1
OPERAND 2
RESULT
NEXT ORDER
NEXT ORDER
SELECTION MATRIX & COUNTER B
OPERAND 2 TO ARITHMETIC UNIT
FROM MEMORY

Fig. 12—Simplified organization of central control.

The operation of central control while making a given selection from the internal memory involves a spatial selection of one of 255 delay lines and a temporal selection of one of 16 word positions within the line. The address of any memory position is specified by a 12-digit binary number, the lower-order four digits of which refer to the temporal selection, while the upper-order eight digits refer to the spatial selection.

A selection of one of 2^n gating lines in accordance with an n-digit binary number governing the selection can be effected through the use of a diode matrix. Fig. 13 shows an elementary matrix in which a two-digit binary number contained in two flip-flops selects one of four gating tubes. The principle of operation depends upon the fact that the impedance across a parallel combination of diode gates varies only slightly with the

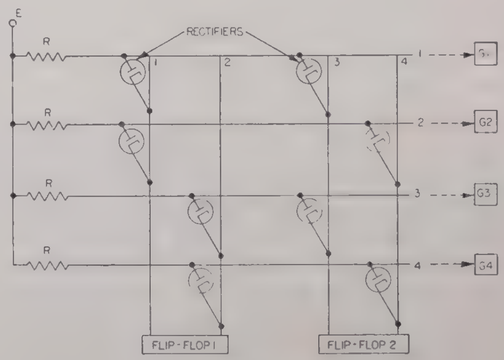


Fig. 13—Rectifier matrix.

number of gates closed if at least one gate is closed, but changes abruptly when all gates are opened. The rectifier matrix of Fig. 13 can be extended in both directions to accommodate as many binary digits as desired.

VI. Magnetic Memory

The magnetic memory units serve to augment the internal memory of the computer, to introduce initial data and commands into the machine, and to record the results of computation. These units make use of magnetic tape as a permanent continuous-storage medium. Each unit has a capacity of approximately 200,000 words, and is capable of operating at a maximum rate of 500 words per second.

Communication between the magnetic-tape units and the other parts of the machine is under the jurisdiction of the central control. Each unit has assigned to it an address which is of the same form as an internal memory address, except that the address in this case includes one of the three operation codes: read, write, and hunt. The read and write codes are always interpreted as applying to the next consecutive word position on the magnetic tape. The hunt code causes the tape unit to hunt for a particular word position, the number of which is supplied by central control.

Because the central control may call upon a magnetic memory unit at highly irregular rates, it is not feasible to propel the tape in response to each individual command. Instead, information is recorded on the tape in blocks of 16 words each and the tape mechanism always operates to read or write an entire block. A mercury-delay-line reservoir consisting of two 16-word delay lines is associated with each tape unit, as shown in Fig. 14. During a sequence of writing operations, the words to be written are accumulated in the consecutive word positions of this reservoir. When 16 words have accumulated in either delay line, the tape mechanism is actuated by local controls, and the contents of the reservoir are transferred to the tape. During a sequence of reading operations, the reservoir is filled from the tape, and as soon as one of the delay lines has been emptied by central control, the tape starts and refills the delay line.

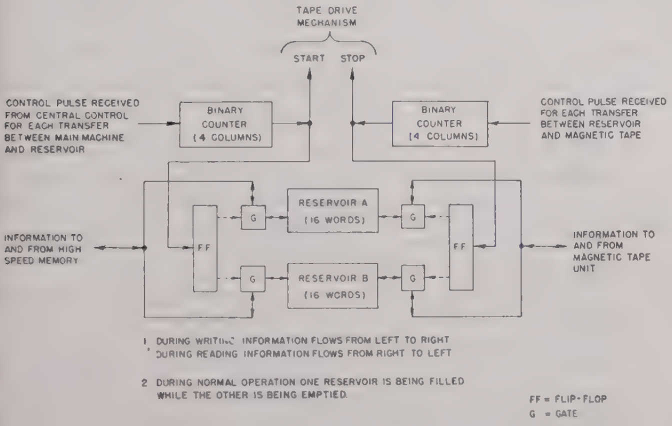

TAPE DRIVE MECHANISM
START
STOP
CONTROL PULSE RECEIVED FROM CENTRAL CONTROL FOR EACH TRANSFER BETWEEN MAIN MACHINE AND RESERVOIR
BINARY COUNTER (4 COLUMNS)
BINARY COUNTER (4 COLUMNS)
CONTROL PULSE RECEIVED FOR EACH TRANSFER BETWEEN RESERVOIR AND MAGNETIC TAPE
INFORMATION TO AND FROM HIGH SPEED MEMORY
FF
G
RESERVOIR A (16 WORDS)
G
FF
INFORMATION TO AND FROM MAGNETIC TAPE UNIT
G
RESERVOIR B (16 WORDS)
G
1 DURING WRITING INFORMATION FLOWS FROM LEFT TO RIGHT
DURING READING INFORMATION FLOWS FROM RIGHT TO LEFT
2 DURING NORMAL OPERATION ONE RESERVOIR IS BEING FILLED WHILE THE OTHER IS BEING EMPTIED.
FF = FLIP-FLOP
G = GATE

Fig. 14—Organization of magnetic-memory-unit reservoirs.

The recording medium is $\frac{1}{4}$-inch-wide magnetic tape on which five parallel channels are recorded. Four of these contain information, and the fifth serves as a marker or control channel. The marker channel contains markers which identify the beginning and end of each block of 16 words, as well as binary numbers which consecutively identify the blocks.

The maximum speed of operation of the magnetic memory units depends upon the pulse-repetition rate per channel and the time required for starting and stopping the tape. With operation rates of several hundred words per second, it may be necessary to accelerate the tape at several thousand inches/sec/sec. Fig. 15 shows the arrangement of a tape-drive mechanism which permits rapid acceleration. A magnetic clutch and drive capstan is used to propel a short segment of tape which is in contact with the recording heads. Spring slack absorbers are used to average the motion of the active portion of the tape and to control servomechanisms which drive the take-up reels.

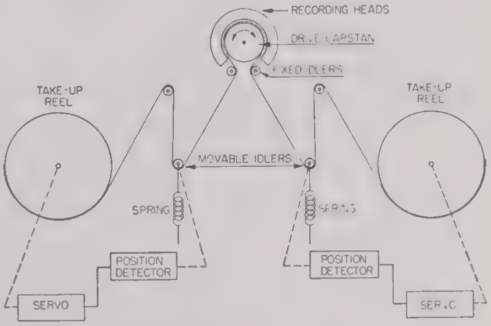

RECORDING HEADS
DRIVE CAPSTAN
FIXED IDLERS
TAKE-UP REEL
TAKE-UP REEL
MOVABLE IDLERS
SPRING
SPRING
POSITION DETECTOR
POSITION DETECTOR
SERVO
SERVO

Fig. 15—Input-output drive mechanism.

VII. Checking

It is desirable that a computer be self-checking in order to minimize the number of undetected errors. The error-checking mechanism should be highly diagnostic, so that the location of a defective part is indicated whenever an error occurs. By incorporating diagnostic checking equipment in the design, the trouble shooting of equipment failures is greatly facilitated and the per cent of the total time during which the machine is operative is proportionately increased.

Numerous methods for checking digital computers have been suggested. Some of these include the simultaneous operation of duplicate equipments, the repetition of each operation or its inverse on the same equipment, and the use of operational checks which involve the periodic running of a test problem.

Checking by duplication of equipment may be undesirable for several reasons. The total amount of equipment is doubled, thereby doubling the cost as well as the total frequency of failures. Repeating each operation or its inverse reduces computation speed by one-half. It also seems doubtful that checking schemes based on the repetition of each operation can be made sufficiently diagnostic to indicate the location of a failure. The periodic running of a test problem has many of the disadvantages cited above concerning loss of speed and lack of diagnostic information. The existence of a time lag between an error and its detection makes it difficult to determine the exact point in the computing routine at which failure occurred, and consequently increases the difficulty of resuming operation. It is possible that intermittent errors might escape detection altogether. It may also be difficult or impossible to construct a test problem which completely checks the machine (e.g., tests all storage positions or all control circuits).

A general system of checking developed by Bloch,[1] known as the method of weighted counts, is believed to offer numerous advantages in regard to economy, reliability, speed, and diagnostic ability. A particular adaptation of this theory is used to check memory storage, word transfers, and arithmetic operations in the present machine.

The successive digits of a binary number may be said to be valued or weighted with the value 2^n where n is the number of the column. The conventional value of the number is then the sum of the weights of those columns in which 1's appear. A different number can be obtained by weighting the columns in a different manner. For example, successive columns may be given the weights 1, 2, 4, 1, 2, 4, etc. The new number is the sum of the weights off all columns in which the digit 1 occurs. This new number (or rather, the lowest-order four digits of it) is called the weighted count of the original number. Each number stored in the computer has its weighted count stored with it (note the group of checking pulses in Fig. 3). A number can be checked whenever desired by formulating a new weighted count and checking this for identity with the weighted count carried with the number. Such a check is performed each time a number is transferred from one location to another.

It can be shown that the basic arithmetic processes can be checked by means of the weighted count. Such checks are possible because the sum (difference, product) of the weighted counts of two numbers has a known relation to the weighted count of the sum (difference, product) of the numbers.

The weighted-count system of checking storage and transfers is operative throughout the machine. When initial input data and commands are manually recorded in the problem preparation unit, weighted counts are generated simultaneously with the depression of the recording keys. Thenceforth, each word contains its own weighted count. Each transfer of a word from the time of manual recording up to and including the time when results are printed by a page printer is checked by the weighted-count process.

Additional checking methods are used to verify the selection of memory positions, and the transfer of operation codes. A selection from the memory involves a temporal selection from among the 16 information word positions in each line and a spatial selection from among the 255 delay lines. Each delay line has a seventeenth word position which contains the binary number of the line. Whenever a line is selected, the number of the line is taken from this seventeenth word position, and is compared for identity with the number of the line as it occurs in the command governing the selection. An additional delay line is used to check temporal selections. This line operates in synchronism with the 255 information lines. The 16 information word positions of the extra line contain the binary numbers from zero to fifteen. Each time a word is taken from an information line, a word is simultaneously gated out of the extra delay line, and the number so obtained is compared for identity with the word position as it appears in the command governing the selection. In this way, each selection made from the memory is checked during the selection cycle in which it occurs.

The transmission of operation codes from the central control to the arithmetic unit is checked by incorporating a code generator in the latter unit. For each arithmetic operation the code generator returns an operation code to central control for checking purposes.

Although the checking system is elaborate, in the sense that each function of the computer is checked during each operating cycle, the equipment necessary to provide such checking does not exceed 20 per cent of the total equipment in the computer. The checking equipment has associated with it a set of controls and neon lights which operate to stop the machine in the event of an error and to indicate the location of the fault. The actual numbers and commands which were being processed when the error occurred are displayed to the machine operator. By virtue of these diagnostic aids, a defective part or subassembly can be quickly located and replaced, in many cases without loss of information or the disruption of the computing routine.

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Signal-to-Noise Ratio in AM Receivers*

EUGENE G. FUBINI†, SENIOR MEMBER, IRE, AND DONALD C. JOHNSON‡

Summary—**Experimental tests have been made to determine the effect of linear detectors upon the signal and the signal-to-noise ratio obtained from the demodulation of an rf carrier. The experimental data confirm theoretical results and indicate that:**

1. The concept of excess noise figure must be used with care. It cannot be employed to calculate the noise at the output of a receiver unless due consideration is given to the presence of a nonlinear device following the if stage. The reason for this is the effect of the presence of a carrier on the noise output of a detector. This noise increases when a carrier is present; the maximum increase is 4 to 7 db, depending upon the shape of the if filter.

2. For sine-wave amplitude modulation and if bandwidths at least 3 or 4 times larger than the af bandwidth, a universal curve can be given that shows the relation between the signal-to-noise ratio at the output and the carrier-to-noise ratio at the input of a second detector.

3. If two AM carriers are simultaneously present at the input of a linear second detector, this discriminates against the modulation of the weaker carrier.

INTRODUCTION

THE INFLUENCE of the second detector on the performance of a system involving the use of modulated radio frequencies is well known for the cases of frequency modulation and pulse modulation, while only recently has a substantial amount of work been done for the case of amplitude modulation. It has often been assumed, for instance, that an AM receiver will furnish at the output of its audio or video stage a signal-to-noise ratio that does not depend upon the bandwidth of the if stage; this assumption has led to the use of the AM receiver as a standard for the measurement of the "improvement" due to FM or other types of modulation. On the other hand, in some cases (radar receivers, for instance), the if bandwidth of AM receivers has been considered as one of the essential parameters that determine the performance of the set. It is also well known that FM systems discriminate against interfering signals in favor of the strongest signal present, but it is seldom mentioned and often forgotten that a similar phenomenon may well occur in any nonlinear system. The so-called "linear detector" used in AM receivers is by definition a detecting—and, therefore, a nonlinear—device; it is not surprising, therefore, to find that, as in FM, AM linear detectors do discriminate in favor of strong signals.

It may be useful to consider in detail the very common assumption that the output signal-to-noise ratio of AM communication receivers is independent of the if bandwidth. Consider a linear detector that follows an if stage and precedes an audio amplifier. At the input of the detector, there is a modulated carrier and some noise; at the output, there will be an af signal and some noise. If the carrier is strong, the spectrum of this noise is practically uniform because the beats between noise components are negligible when compared with the beats between the carrier and the noise, and the latter are uniformly distributed from zero cps to a frequency equal to half the if bandwidth.[1] Since af stages pass only part of this uniform spectrum, it is obvious that, when the carrier is strong, the noise at the output will depend only upon the bandwidth of the audio filter and upon the noise density; it will be independent of the if bandwidth.

In low-frequency applications, the if bandwidth is usually of the order of the bandwidth of the audio or video stage; for acceptable service, the signal at the output of the detector must be several db above the noise level. This condition usually requires that the carrier at the input of the detector be several db above the noise level. For this reason, the assumption that the signal-to-noise ratio at the output is independent of the if bandwidth holds in most of the low-frequency applications. At very high frequencies (around 100 Mc or more), however, the if bandwidth can well be 100 times wider than that of the audio or video stages, and the noise level at the input of the second detector will not necessarily be small compared with the signal, even when this is large enough for acceptable service.

These questions then arise: How strong does the signal need to be, as compared with the noise, in order to make the output signal-to-noise ratio independent of the if bandwidth, and what happens if the signal is not strong enough?

This paper will deal first with the effect of the presence of an unmodulated carrier on the noise at the output (audio or video) of an AM receiver. Modulated carriers are then considered, and the amplitude of the signal and its relation to the noise level are discussed.

The theory of detection of rf signals in the presence of noise for different spectral shapes, percentages of modulation, and detector characteristics has been rigorously developed by Middleton.[2]

EFFECT OF AN UNMODULATED CARRIER ON THE OUTPUT NOISE

Consider a detector with a noise voltage applied at its input and consider the noise as a voltage caused by the presence of many components comparable in ampli-

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[1] These considerations are only qualitatively correct; they assume, for instance, a carrier centered with respect to a symmetrical and uniform (square) if filter.

[2] David Middleton, "Rectification of a sinusoidally modulated carrier in the presence of noise," PROC. I.R.E., this issue, pp 1467–1477.

tude and random in phase. Assume now that a very small if carrier is introduced at the input of the second detector and that its amplitude is comparable with that of one of the noise components. The detector will treat the carrier as if it were just another noise component. To the noise beats existing in the absence of the carrier, new beats will be added with an amplitude roughly proportional to the carrier amplitude c. Since all these beats are random with respect to each other, the total noise power n^2 in the presence of the carrier can be expressed as

$$n^2 = n_0^2 + k^2c^2,\quad k^2c^2 \ll n_0^2 \qquad (1)$$

where n_0^2 is noise power in the absence of the carrier, k^2 is a proportionality constant, and c^2 is the carrier power. Fig. 1 represents (1) graphically; n^2 (in db referred to n_0^2) is plotted against c^2 (in db referred to n_0^2/k^2).

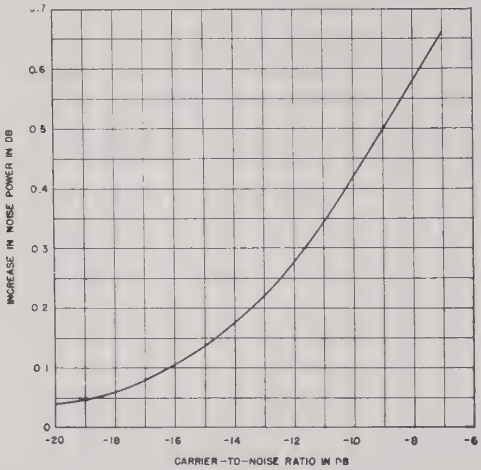

Fig. 1—Increase in noise power at the output of an audio- or video-frequency amplifier due to the presence of a carrier at the input of the second detector. This curve is based on the broad assumptions described in the text; it is not quantitatively accurate.

It is obvious that the preceding assumptions and the resultant Fig. 1 are only qualitatively accurate, but they are helpful in visualizing how the noise at the output of an AM receiver increases when a small if carrier is present at the input of the second detector.[3] It is easy to realize that the noise at the output will soon level off at a few db over its no-carrier value. It is well known, in effect, that the if voltage in a receiver is independent of the amplitude of the local-oscillator voltage if the latter is large enough. Similarly, the noise in the audio or video stage must be independent of the if carrier amplitude if the latter is large enough. It can be said roughly that when the if carrier voltage is large the carrier-noise beats "ride" on top of the carrier, and the noise voltage, after detection, is then obviously not a function of the carrier level.

The results of the experiments and of the rigorous theory are plotted in Fig. 2. Two curves give the theoretical values for an "optical"[4] spectral shape and for a uniform (square) spectral shape. The other four curves give the experimental data on the amount of noise power present at the output of an af amplifier for two if bandwidths (4.2 and 1.7 Mc) and two af bandwidths

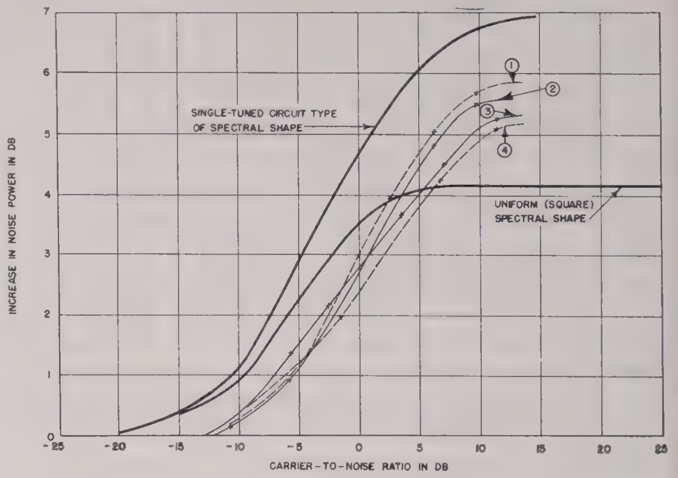

Fig. 2—Comparison between experimental and theoretical results on the increase in noise power at the output of an audio- or video-frequency amplifier due to the presence of a carrier at the input of the second detector preceding it. The two heavy lines are the theoretical curves for "optical" and uniform spectral shapes. The other four curves represent experimental results for the following if and af bandwidths:

Curve 1—4.2-Mc if, narrow af;
Curve 2—4.2-Mc if, wide af;
Curve 3—1.7-Mc if, narrow af;
Curve 4—1.7-Mc if, wide af.

The increase in noise power is referred to the noise present at the output when no carrier voltage is present.

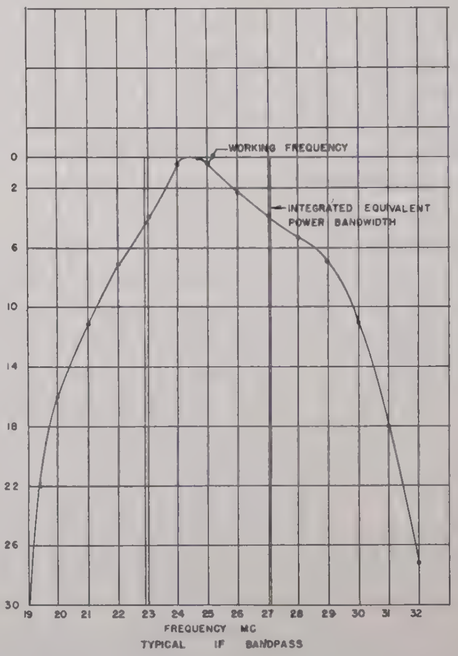

Fig. 3—Typical shape of if selectivity curve showing integrated equivalent power bandwidth.

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[3] This increase is completely unrelated to the effect of the first detector on the noise present in the if stage.

[4] "Optical spectrum" is a term introduced by J. H. Van Vleck of Harvard University to represent a spectral shape equal to the selectivity curve of a single-tuned circuit.

(roughly, from 100 to 1100 cps and from 100 to 3700 cps). It appears clear from Fig. 2 that, according to theory, the spectral shape has a definite effect on the total increase in noise output between the no-carrier condition and the infinite-carrier condition (Fig. 3 shows a typical shape of the if stages used in the tests). It must be emphasized, however, that, although this increase depends upon the selectivity curve of the if stage, it does not depend, for a given spectral shape, upon the actual width of the if band. The reason behind this result is the normalizing effect obtained by referring the ordinates in Fig. 2 to the noise at the output when no carrier is present. The theoretical curve given for the case of uniform spectral shape is exactly the same as that given by Bennett.[5]

The application of this theory is limited to the case in which the if bandwidth is substantially larger than the af bandwidth. The theoretical results obtained by Middleton show that a ratio of 3 or 4 between half of the if bandwidth and the af bandwidth is sufficient to guarantee satisfactory accuracy.[6] The theoretical and experimental curves show a general trend common to both, but there is a discrepancy for the case of low-input carriers that cannot be easily explained.

The carrier-to-noise ratio at the input of the second detector was determined experimentally by a method suggested by North.[7] It is based on the principle that a dc voltage measured across a diode detector whose time constant is equal to the reciprocal of the if bandwidth will increase by a factor of 3 db if a nonmodulated if carrier is applied whose rms voltage is equal to the rms noise voltage. The results are independent of the spectral shape.

In calculating the useful range of some AM communication systems, it will be worth while to remember that the noise increases from 4 to 7 db when a carrier is present.

LINEAR DETECTION OF AN RF CARRIER IN THE PRESENCE OF NOISE

The rigorous theory shows that *any* detector will act as a square-law detector for carriers whose amplitudes are very small in comparison with the noise level. It is the purpose of this section to give experimental confirmation of this theoretical conclusion and to offer some nonrigorous explanations. Referring to (1) and considering the case in which the carrier is 100 per cent modulated, one finds that the noise varies with the modulating voltage. It can be assumed to a first approximation that the fundamental component m of the modulation is proportional to the difference between the noise voltages when the carrier is present and when the carrier is not present. We obtain, therefore, the approximate formula

$$\begin{aligned} m &= h(\sqrt{n_0^2 + k^2c^2} - n_0) \\ &\cong h\left[n_0\left(1 + \frac{k^2c^2}{2n_0^2}\right) - n_0\right] \\ &= \frac{hk^2c^2}{2n_0} \qquad (2) \end{aligned}$$

where m is the fundamental audio- or video-frequency component at the output, and h is a proportionality constant.

Equation (2) indicates that when the signal is small the detector follows a square law. Although this reasoning is only qualitatively accurate, the experiments and the rigorous theory check the conclusions. It is clear from Fig. 4 (which represents the result of a typical experiment) that the slope of the curve is 1 for large carrier inputs and about 2 for small carrier inputs, confirming the fact that the detector acts as a square-law detector for small carrier inputs.

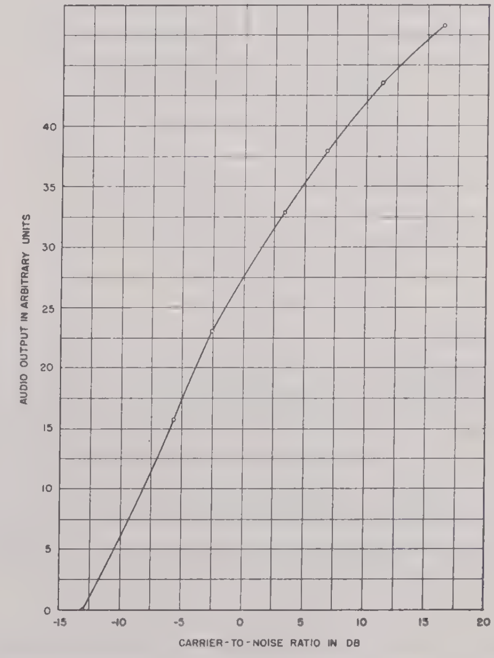

Fig. 4—Experimental determination of the effect of noise on the characteristic of a linear detector. The ordinates represent the af voltage obtained after a sine-wave-modulated rf voltage was detected and filtered. The curve shows that, for low carrier inputs, a linear detector becomes a square-law detector.

The above result (or, for that matter, any of the results presented in this paper) must not be attributed to the fact that any linear detector realizable in practice becomes nonlinear if the voltage applied to it is small enough. The experiments were conducted with a type 9005 diode detector, which is linear when the voltage applied is greater than 0.2 volt (see Fig. 9). The noise at the output of the if amplifier in the absence of a carrier was greater than 0.7 volt, so that for all practical purposes the detector was operated well in the linear region of its characteristic, even with the smallest carrier input.

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[5] W. R. Bennett, "Response of a linear rectifier to signal and noise," *Bell Sys. Tech. Jour.*, vol. 23, pp. 97–113; January, 1944.

[6] D. Middleton, "The response of biased, saturated linear and quadratic rectifiers to random noise," *Jour. App. Phys.*, vol. 17, p. 789, Fig. 11; October, 1946.

[7] D. O. North, unpublished synopsis of "The modification of noise by certain nonlinear devices," presented at the 1944 IRE Winter Technical Meeting, New York, N. Y., January 28, 1944.

The Signal-to-Noise Ratio

Comparing Fig. 2 and Fig. 4, one sees that, for large signals, the noise is constant, and that the audio or video output increases linearly with the carrier input. This means that the signal-to-noise ratio in this region will also increase linearly with the input; in other words, an increase of, say, 3 db in the carrier input corresponds to a 3-db improvement in signal-to-noise ratio at the output. Again comparing Fig. 2 and Fig. 4, one finds that for very small carrier inputs the noise is practically constant, and the audio- or video-frequency signal is a quadratic function of the carrier input. If, therefore, one plots signal-to-noise ratio in db versus carrier input in db, one would expect to obtain a curve that, for large signals, would be asymptotic to a line with a slope of 1 and, for small signals, to a line with a slope of 2.

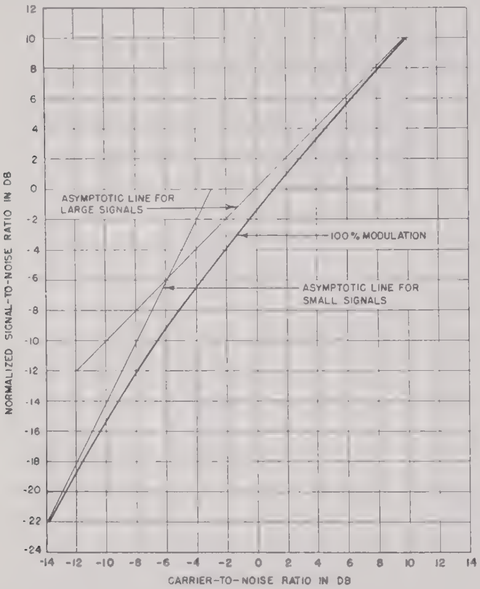

Fig. 5—Universal curve for determining the signal-to-noise ratio at the audio or video output of an AM receiver. The curve is valid for sine-wave modulation when the af bandwidth is much (at least 3 or 4 times) smaller than the if bandwidth. The signal-to-noise ratio is normalized to take into account the different if to af bandwidth ratios of different receivers; each ordinate represents the calculated value of the signal-to-noise ratio at the output in db minus 10 log (if bandwidth)/(2×af bandwidth). Modulation coefficients m different from 1 per cent can be taken into account with good approximation (errors less than 0.3 db in all practical cases) by decreasing the ordinates by 20 log $1/m$.

The rigorous theory confirms this result, and the curve resulting from it (for the "optical spectral" case) is shown in Fig. 5. It is important to note that Fig. 5 represents a universal curve that is valid for any if and af bandwidth so long as the if bandwidth is at least 3 or 4 times larger than the audio- or video-frequency bandwidth. The carrier input is plotted in db referred to the input noise power, and the signal-to-noise ratio is plotted in "normalized" db. Normalization is necessary in order to make the curve universal: the signal-to-noise ratio at the output is plotted in such a way as to take into account the different if and af bandwidths of various receivers; a number equal to

$$10 \log \frac{\text{if bandwidth}}{2 \times \text{af bandwidth}}$$

is subtracted from the calculated or measured value of db before it is plotted in the diagram. In practice, if one dealt, for example, with a receiver whose if bandwidth was 100 kc and whose af bandwidth was 3 kc, one would have to *add* to the value of signal-to-noise ratio read as an ordinate, a number equal to 10 log $100/6 = 12.2$ db. In general, one should always *add* to the ordinate read in the diagram the number of db corresponding to the ratio given above.

Before discussing the experimental results, it may be useful to examine in detail the consequences of the theory. Consider two receivers that are exactly alike except for the fact that the excess noise figure is 3 db worse for the first receiver than for the second. This would mean that, for the same carrier input if, the value read as an abscissa would be 3 db higher for the better receiver than for the worse one; from Fig. 5, it appears that the signal-to-noise ratio would also be 3 db worse in the first receiver when the carrier input was large enough, but that it might be up to 6 db worse if the carrier input was very small.

If one considers two receivers that are otherwise identical but whose af stages have bandwidths in the ratio of 2 to 1, one will find that, irrespective of the values of the carrier input, the signal-to-noise ratios at the output will always differ by 3 db, provided, of course, that the if bandwidth is substantially larger than the af bandwidth.

It is more difficult to visualize the case of two receivers identical in every respect but having different if bandwidths. This difficulty occurs because changing the if bandwidth introduces changes both in the abscissa and the ordinates of the diagram. For instance, doubling the if bandwidth, while leaving the signal unchanged, means shifting the reading on the abscissa 3 db to the left and adding to the reading on the ordinate 3 db more than in the preceding case. If the carrier input is large enough, this does not result in any change in the output signal-to-noise ratio. However, if the signal is small enough, the signal-to-noise ratio at the output may decrease as much as 3 db. Consider, for instance, a receiver with an if bandwidth of 100 kc and an af bandwidth of 3 kc, and consider the case in which the carrier-to-noise ratio at the input of the second detector is -8 db; the normalized signal-to-noise ratio at the output, as read in Fig. 5, is about -12.2 db. The actual signal-to-noise ratio is, therefore, equal to $-12.2 + 10 \log 100/6 = 0$ db.

Now suppose that the if bandwidth of the receiver is doubled and the carrier input remains the same. The carrier-to-noise ratio becomes −11 db (instead of −8 db) and the normalized signal-to-noise ratio, as read in Fig. 5, becomes about −16.8 db (instead of −12.2 db). The actual signal-to-noise ratio in this case will be $-16.8+10 \log 200/6=-1.6$ db.

In the region of small carrier inputs, therefore, the effect of doubling the if bandwidth is to impair the signal-to-noise ratio by amounts that increase from 0 to 3 db with decreasing carrier input.

Experimental checks of the theoretical results have been made at 30 Mc, using three different if bandwidths (12.6, 4.2, and 1.7 Mc) and two af bandwidths (1060 cps and 3600 cps). The results of the experiments are shown in Fig. 6. It is apparent that the signal-to-noise ratio measured for small carrier inputs is almost always a little worse than that predicted by the theory. This is only partially due to the assumption made in the theory that the spectral shape is "optical"; the differences are, at any rate, of the order of the experimental errors made in calculating the if and af bandwidths, in measuring the percentage of modulation, etc.

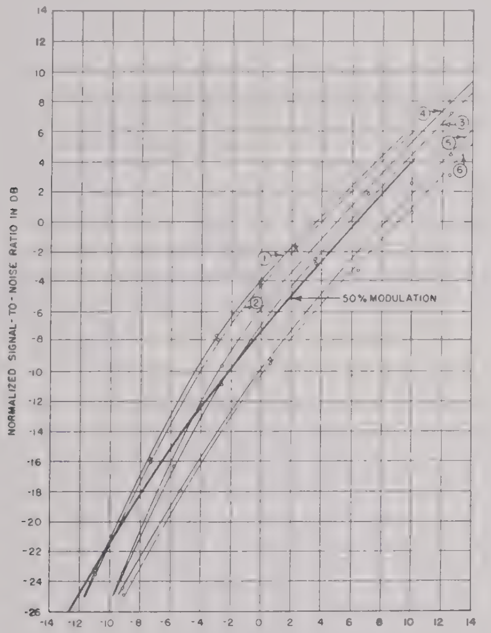

Fig. 6—Comparison of theoretical and experimental data. The 50 per cent modulation curve is obtained by means of a 6-db shift of the 100 per cent modulation curve in Fig. 5. The other six curves represent experimental results for the following if and af bandwidths:

Curve 1—12.6-Mc if; wide af
Curve 2—12.6-Mc if; narrow af
Curve 3—4.2-Mc if; narrow af
Curve 4—4.2-Mc if; wide af
Curve 5—1.7-Mc if; narrow af
Curve 6—1.7-Mc if; wide af

The modulation percentage used in the experiments was 50 per cent. The ratio between the wide and the narrow af bandwidths corresponds to a 5.3-db difference in the signal-to-noise ratio.

DISCRIMINATION AGAINST WEAK SIGNALS

Fig. 4, which shows that a linear detector becomes a square-law detector when the signal is small enough, could be interpreted as stating that a linear detector discriminates against the signal in favor of the noise when the signal level is below the noise level. On the same basis, one would expect that, if two equally modulated rf carriers were present at the input of a linear detector, the ratio of the amplitudes of the two corresponding audio frequencies would not be equal to the ratio of the two carrier amplitudes; in other words, one would expect that, if two signals were present, the linear detector would discriminate in favor of the stronger signal.

This conclusion can be shown to be correct. Two signals were introduced at the input of an if amplifier, one with sine-wave modulation and the other unmodulated. When the unmodulated signal had an amplitude greater than that of the modulated signal, the af voltage at the output decreased—the same effect as that due to overload in an average amplifier. The voltages utilized, however, were such that both the detector and the amplifier were still working in the linear portion of their characteristics. The results of the experiment are plotted in Fig. 7.

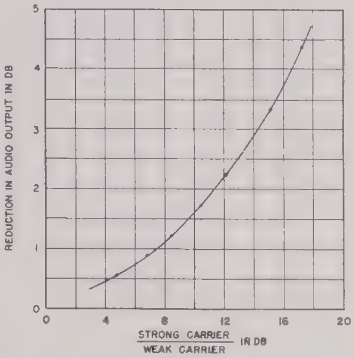

Fig. 7.—Experimental data showing how the audio output resulting from the detected modulation of one carrier is reduced by the simultaneous presence of a stronger carrier at the second detector. (That part of the curve for values of the abscissa greater than 12 db may have been somewhat influenced by a slight nonlinearity in the amplifiers.)

CONCLUSIONS

It has been shown that it is possible to predict to a reasonable approximation the signal-to-noise ratio at the output of an AM receiver as a function of the if and af bandwidths and the carrier level at the input. This paper has dealt exclusively with sine-wave modulation and with if bandwidths substantially larger than af bandwidths. Experiments confirm the validity of a universal curve calculated from Middleton's theory, which gives the desired relations for any ratio of if to af bandwidths greater than 3 or 4. The following conclusions can be drawn:

1. There is a form of threshold for AM receivers; below this threshold, the influence of the if bandwidth on the performance of the receiver becomes increasingly important. When the carrier rms voltage is equal to the noise rms voltage, the influence of the if bandwidth is reasonably small (a 2 to 1 change in the if bandwidth

will cause about a 1-db change in the output signal-to-noise ratio).

2. The excess noise figure measured after the second detector of a receiver is a function of the carrier amplitude; care should be used, therefore, in applying the concept of excess noise figure to the calculation of noise output of a receiver.

3. The noise level increases in the presence of a carrier by an amount that is a function of the shape of the if selectivity curve, but that is independent of the values of the if and the af bandwidths.

4. An AM receiver is not a linear device. For example, if two rf signals of different amplitudes but with the same percentage of modulation are present at the input of a second detector, the corresponding audio- or video-frequency voltages, after detection and filtering, are not in the ratio of the two rf carrier amplitudes (unless this ratio is 1 to 1). The detector always discriminates in favor of the modulation of the stronger carrier.

Appendix—Experimental Procedure

The experiments were conducted at 30 Mc, using an if amplifier and a standard-signal generator. The detector was followed by an af preamplifier, a filter, and a power amplifier that was terminated with a thermocouple and a wave analyzer in parallel. (See Fig. 8.)

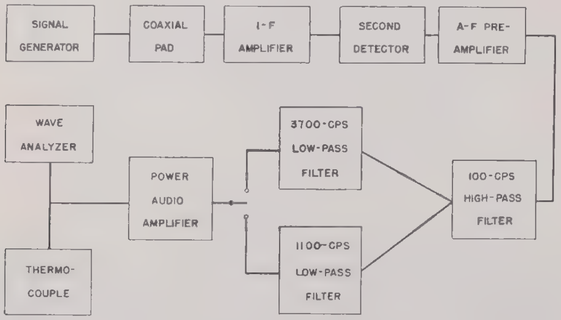

Fig. 8—Block diagram of the experimental setup used for the measurements.

A General Radio signal generator type 805A provided the if signal source. This signal generator gives a modulated or unmodulated rf output continuously variable from 0.1 microvolts to 2 volts and 400-cps modulation variable from 0 to 100 per cent. A Western Electric coaxial pad was used between the generator and the input of the if amplifier to give an attenuation of 20 db. The if strip, which used type 6AC7 tubes, was originally built for a type SPR-2 receiver. It was modified for single-tuned interstage coupling. The if strip was followed by a type 9005 diode detector which was, in turn, followed by a two-stage af preamplifier, feeding into a filter system consisting of a high-pass filter with a 100-cps cutoff and a low-pass filter with either a 1100-cps or a 3700-cps cutoff. The output of the filter system was fed into a power amplifier, and the output of the amplifier was fed to a General Radio wave analyzer type 736A connected in parallel with a Western Electric vacuum thermocouple type 20A.

The linearity of the diode detector was tested by measuring dc output versus rf input (Fig. 9); the diode was found to be linear down to an input as low as 0.2 volt. Since the dc reading due to noise at the output of the diode was never allowed to go below 0.7 volt, the diode for all practical purposes was operated on the linear portion of its characteristic. The bandwidth of the af filter system was calculated by graphical integration of the power versus frequency curve, and the ratio between the two af bandwidths corresponded to 5.3 db. The linearity of the if amplifier for large signals was checked by feeding a modulated rf signal into the input of the if amplifier, reducing the modulation, and increasing the amplitude to maintain a constant output. The exact value of each if bandwidth of the three amplifiers used was calculated by graphically integrating the area under the if selectivity power curve and by referring the equivalent width to the amplitude of the curve at the frequency used for the measurements (see Fig. 3).

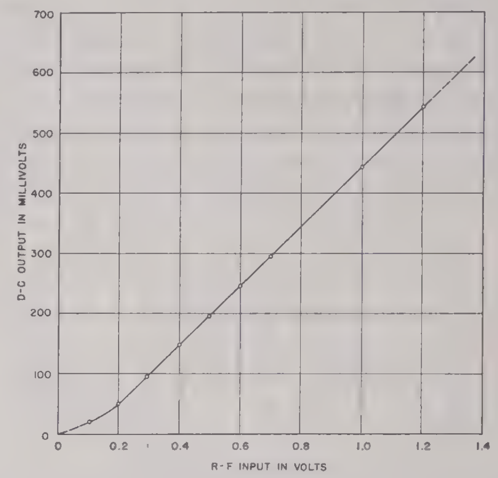

Fig. 9—Characteristic of the type 9005 diode, showing the linearity of the characteristic down to input voltage of the order of 0.2 volt.

The signal-to-noise ratios were measured as follows. For each value of rf input, the audio signal at 400 cps was read on the wave analyzer, and the signal-plus-noise power was simultaneously read on the thermocouple. The modulation percentage was 50 per cent. The modulation was then turned off, and the noise power alone was measured with the thermocouple. For each carrier input level, the measurements corresponding to the narrow and the wide af bandwidths were taken consecutively. Conversion factors between the thermocouple and the wave analyzer were determined, using the modulated-output reading on the thermocouple when noise was negligible. The signal output voltages read on the wave analyzer were then converted to thermocouple units of power, and the signal-to-noise ratio was computed.

Rectification of a Sinusoidally Modulated Carrier in the Presence of Noise*

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Summary—**The low-frequency output, signal and noise, is determined following a general νth-law ($\nu>0$) half-wave rectification of a sinusoidally modulated carrier. The spectral width of the noise before rectification is assumed to be much narrower than its mean frequency f_0, the normal condition for reception. Attention is focused on one of the harmonics of the rectified signal, generally the first, whose modulation frequency is small compared to the if frequency f_0 and to the width of the noise band. Special attention is given to the important cases of linear ($\nu=1$) and quadratic ($\nu=2$) detection, and audio signal-to-noise ratios s_a/n_a are calculated for them. The noise passed by the audio filter is found to depend on the spectral shape of the if; for the three types of if filter specifically considered, namely, rectangular, gaussian, and "optical," the optical yields the least, the rectangular the most noise; provided, of course, that the mean input signal-to-noise power p is of the order of unity or less, the customary region of interest. When $p\ll 1$, all half-wave detectors ($\nu>0$) behave like the quadratic device. Modulation ($0\leq\lambda\leq 1$) does not radically affect the output noise power, particularly when ($p>1$), and for very large signals, $p\to\infty$, s_a/n_a is directly proportional to the input carrier amplitude, is independent of if filter width, and is only slightly dependent on filter shape. The best if filter is one whose response is the modulus of the Fourier transform of the signal, as in the radar case of pulsed signals. The theory is in good agreement with the experimental results for the linear rectifier, and a number of theoretical curves illustrating the variation of the audio ratio s_a/n_a with p are also included.**

I. Introduction

IN RECEIVERS the observability of a signal is limited by the accompanying noise, originating either in the receiver elements themselves or coming in with the carrier from external sources. Now, in all cases the complicating factor is the nonlinear device, the second detector, by which demodulation of the carrier is accomplished.[1] Signal and noise enter this element simply as the sum of their instantaneous amplitudes, but leave it in quite a different manner. The nonlinearity of the detector produces beats between components of the noise ($n\times n$), the signal and noise ($s\times n$), and the signal with itself ($s\times s$). What then appears is no longer the "pure" noise and "pure" signal that entered originally, but noise modified by the presence of the signal, and more significantly, especially for small signals, signals that are altered by the noise. Under these circumstances it has been found that a useful criterion by which to estimate the performance is the signal-to-noise ratio, obtained at the output in a manner appropriate to the type of receiver in question. This ratio, in turn, may be related to the incoming signal and noise in a fashion depending on the filter response, detector characteristic, and mode of presentation of the apparatus.

Our present problem concerns the rectification of a sinusoidally modulated carrier, accompanied by random noise. The bandwidth ($\sim\Delta f_{\text{noise}}$) of the if stage is taken to be much larger than the modulation frequency f_A and much less than the mean frequency of the band f_0, so that the low-frequency output of the detector may be easily separated from the higher spectral zones generated by the cross-modulation of the components of the input (see Fig. 1(a)). Of this low-frequency output, only the spectral region in the neighborhood of $f=0$ is of interest (Fig. 1(b)), since it contains the harmonic (first or higher) of the modulation, which constitutes the detected signal. A filter Δf cps wide is employed which allows only this harmonic (lf_A, $l=1, 2, 3\cdots$) and the rectified noise in the region $lf_A-\Delta f/2$ to $lf_A+\Delta f/2$ cps to pass. Our output signal-to-noise ratio may then be defined as: the rms value of the lth component of the modulation divided by the rms value of the noise transmitted by the selective audio filter. (It should be noted that the audio filter Δf may be either the natural response of the ear[2] or the response of an electrical filter, whichever is the narrower at this frequency.) This criterion is precisely the same as that for the aural detection of radar signals.[2]

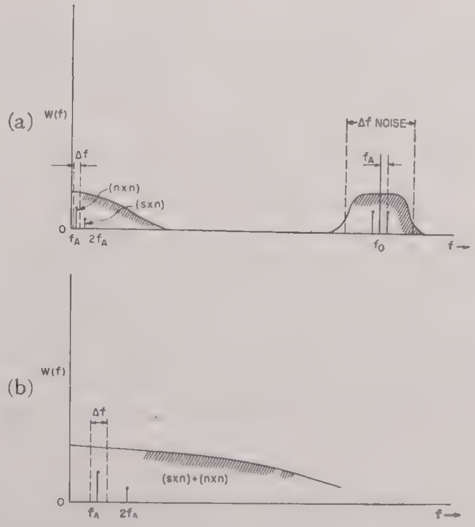

Fig. 1—Spectral distribution of the input and output power after (a) half-or full-wave quadratic detection; (b) low-frequency output.

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[1] Although the first detector or mixer is also a nonlinear element, the presence of a beating-oscillator voltage, large compared with either signal or noise, makes its operation effectively linear in that there is no mixing of signal and noise.

[2] J. H. Van Vleck and D. Middleton, "A theoretical comparison of the visual, aural, and meter reception of pulsed signals in the presence of noise," *Jour. Appl. Phys.*, vol. 17, pp. 940–971; November, 1946. See part I, sec. 1.

Ragazzini[3] has obtained an approximate expression for the output power spectrum when a carrier modulated by a sine wave is impressed on a linear rectifier. His result for the low-frequency part of the output continuum is, as Rice[4] has shown, quite accurate for small indices of modulation, and particularly when the amount of noise relative to the signal is small. Work on related lines by Bennett[5] also bears out this observation. The scope of the present paper is considerably wider than previous efforts, covering all degrees of modulation (0–100 per cent) and all ($\nu > 0$) types of unsaturated half-wave rectifiers. The more precise technique of the present treatment, following the method of Rice,[6] is obtained from generalizations developed by the author in a recent paper.[7] Our purpose, then, is to determine the noise, the audio signal, and signal-to-noise ratios after rectification by a half-wave νth-law detector, and their dependence on input signal, degree of modulation, if spectral shape, etc. Detailed calculations are given for the two important cases of linear and quadratic detection, and three specific if filter responses are considered: rectangular, gaussian, and "optical."

To illustrate the approach, we examine first the simple and important problem of small-signal, full-wave quadratic rectification.

II. Small-Signal, Full-Wave Quadratic Rectification

Following the notation of footnote reference 2, we write, for the amplitude factor of the if carrier entering the second detector,

$$\sqrt{2}\, s_F(t) = A_0(t) = s_F\sqrt{2}\,(1 + \lambda \cos \omega_A t),$$
$$\omega_A = 2\pi f_A, \qquad 0 \leq |\lambda| \leq 1 \tag{1}$$

where λ is the modulation index and ω_A is the (angular) frequency of modulation. The actual wave leaving the if is, exclusive of the noise,

$$A_0(t) \cos \omega_0 t = s_F\sqrt{2}\,(1 + \lambda \cos \omega_A t) \cos \omega_0 t$$
$$(\omega_0 = 2\pi f_0), \tag{2}$$

so that s_F is the rms amplitude of the signal for no modulation ($\lambda = 0$); ω_0 is the angular frequency of the carrier, which is also the same as the central frequency of the noise band, since in all our work the if filter is assumed so tuned that the signal is in the center of the band. Then, the mean total signal power is clearly

$$P_s = s_F^2(1 + \lambda^2/2), \tag{3}$$

of which $\lambda^2 s_F^2/2$ is attributable to the modulation.

Now, from equation (16) of footnote reference 2 or from equation (8.20) of footnote reference 7, the low-frequency correlation[8] function after full-wave quadratic rectification is, exclusive of the dc component due to the noise terms ($n \times n$) and ($s \times n$),

$$R_0(t) = \beta^2\{\psi_0(t)^2 + 2\psi_0(t)\overline{s_F(t_0')s_F(t_0' + t)} + \overline{s_F(t_0')^2 s_F(t_0' + t)^2}\} \tag{4}$$

where the bars indicate the average over the phases (proportional to, t_0') of the modulation, and $\psi_0(t)$ is the correlation function of the if noise band, central frequency removed. (The actual correlation function is $\psi(t) = \psi_0(t) \cos \omega_0 t$. See (11)–(13) of footnote reference 2, and consult Table I for specific examples.) We note that

$$\psi_0(t) = \psi r_0(t) \equiv n_F^2 r_0(t); \qquad n_F^2 \equiv \psi = \psi(0) \tag{5}$$

where $r_0(t)$ is the (normalized) correlation of the input noise referred to the frequency f_0. The quantity β is a scale factor that has the proper dimensions so that, if the incoming wave is a voltage on the grid of the detector, it appears as a current in the output. (It may also appear as any other suitable quantity, depending on the circuit, with the proviso that the circuits in question are primarily resistive, i.e., have only small reactive components over the frequency range of operation. This is to insure the one-valuedness of the dynamic output versus input path.)

The first term in (4) represents noise alone ($n \times n$), the second term gives the cross-modulated noise ($s \times n$) produced when the signal and noise components beat together, while the final term is the contribution due to the modulation itself. The average of the third term in (4) is readily shown to be

$$\overline{s_F(t_0')^2 s_F(t_0' + t)^2} = s_F^4\left\{\left(1 + \frac{\lambda^2}{2}\right)^2 + 2\lambda^2 \cos \omega_A t + \frac{\lambda^4}{8} \cos 2\omega_A t\right\}. \tag{6}$$

The mean power in the harmonic ($f = f_A$) we wish to hear is, then,

$$P_A = 2\beta^2\lambda^2 s_F^4 \equiv s_a^2. \tag{7}$$

Since the noise is assumed to be spectrally wide compared to the modulation frequency, i.e., $\Delta f_{\text{noise}} >> f_A$ (where Δf_{noise} is the width between half-power points of the if noise power spectrum (see Fig. 1)) we may take as the spectrum of the noise output in the neighborhood of f_A the value of the spectrum at $f = 0$. The well-known transform relations between the mean power spectrum and its correlation function[2,4,6,7] permit us to write for the mean noise power transmitted by the audio (or aural) filter of width[9] Δf

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[3] J. R. Ragazzini, "The effect of fluctuation voltages on the linear detector," Proc. I.R.E., vol. 30, pp. 277–288: June, 1942.

[4] S. O. Rice, "Mathematical analysis of random noise," *Bell Sys. Tech. Jour.*, vol. 24, pp. 46–108; January, 1945. See discussion following equation (4.10–11).

[5] W. R. Bennett, "Response of a linear rectifier to signal and noise," *Jour. Acous. Soc. Amer.*," vol. 15, pp. 164–172; January, 1944.

[6] S. O. Rice, "Mathematical analysis of random noise," *Bell Sys. Tech. Jour.*, vol. 23, pp. 282–332; July, 1944; and Part IV of reference 3.

[7] D. Middleton, "Some general results in the theory of noise through non linear devices," *Quart. Appl. Math.*, vol. 5, p. 445; January, 1948.

[8] The correlation function is the Fourier transform of the mean power spectrum. See equation (11).

[9] The audio filter is considered rectangular, of width Δf, which is not a very critical assumption.

$$n_a^2 = [W_0(f)\Delta f]_{f=0} = 4\Delta f\left(\int_0^\infty R_0(t)\cos\omega t dt\right)_{\omega=0}$$

$$= 4\beta^2\Delta f\left\{\int_0^\infty \psi_0(t)^2\cos\omega t dt + 2s_F^2\int_0^\infty \psi_0(t)\overline{(1+\lambda\cos\omega_A t_0')(1+\lambda\cos\omega_A[t_0'+t])}\cos\omega t dt\right\}_{\omega=0}. \quad (8)$$

Because $\Delta f_{\text{noise}} >> f_A$, it is easily shown for any particular case that $\psi_0(t)$ falls off to zero so rapidly for $t>0$ that we may set $\cos\omega_A t = 1$ as well as $\cos\omega t = 1$, i.e., for $\omega = 0$. Then the mean audio noise power (8) becomes

$$n_a^2 = 4\beta^2\Delta f n_F^4\left\{\int_0^\infty r_0(t)^2 dt + (2+\lambda^2)p\int_0^\infty r_0(t)dt\right\} \quad (9)$$

where $p \equiv s_F^2/n_F^2$; see (5).

The rms signal-to-noise ratio follows from (7) and (9), and is

$$\frac{s_a}{n_a} = \frac{\lambda p}{(2\Delta f)^{1/2}}\left\{\int_0^\infty r_0(t)^2 dt + (2+\lambda^2)p\int_0^\infty r_0(t)dt\right\}^{-1/2}. \quad (10)$$

As will be shown later (Part VI), this result also holds exactly for the half-wave quadratic detector ($\nu = 2$).

Before examining any special input noise spectra, we observe at once that the values of the integrals in (10) depend on the spectral shape of the if, and this dependence may be expected to differ for $(n\times n)$ and $(s\times n)$ terms by a not entirely negligible numerical factor. Physically, the argument goes something like this: The spectral contribution near $f=0$ arises from beats between closely adjacent components; hence, the power in beats of this kind produced at high frequencies, i.e., out on the "tails" of the if spectrum, will depend on the power density in their neighborhood, and hence the spectral shape of the if output noise will determine in varying degrees the spectral ordinate near $f=0$ after rectification, as it may be considered as the sum (properly weighted in accordance with the law of the detector; see Section V) of these beats produced in the process of detection. Thus, for a rectangular if spectrum we will get one spectral density near $f=0$; for the gaussian, another.

Table I below gives the salient properties of three common spectral distributions; the correlation functions are calculated from the relations[2,4,6,7]

$$R(t) = \int_0^\infty W(f)\cos\omega t df,$$
$$\left(\text{with } W(f) = 4\int_0^\infty R(t)\cos\omega t dt,\ \omega = 2\pi f\right) \quad (11)$$

where use is made of the fact that the central noise frequency $f_0 >> \Delta f_{\text{noise}}$, so that the if correlation function may be written

$$\psi(t) = n_F^2 r_0(t)\cos\omega_0 t. \quad (12)$$

The various spectral parameters ω_F as determined by the normalization are related by

$$(\omega_F)_{\text{opt.}} = \frac{1}{\sqrt{\pi}}(\omega_F)_{\text{gauss}} = \frac{2}{\pi}(\omega_F)_{\text{rect}}. \quad (13)$$

The audio signal-to-noise ratio (10) then becomes explicitly

$$\frac{s_a}{n_a} = \frac{\lambda p}{\sqrt{2}}\left[\frac{(\omega_F)_{\text{opt.}}}{\Delta f}\right]^{1/2}\left\{\underset{(n\times n)}{\begin{pmatrix}1\\1/\sqrt{2}\\1/2\end{pmatrix}} + \underset{(s\times n)}{\begin{pmatrix}1\\1\\1\end{pmatrix}}p(2+\lambda^2)\right\}^{-1/2} \quad (14)$$

TABLE I

Type of if spectrum	Analytic form	Low-frequency correlation $r_0(t)$	$n_F^{2*} \equiv \psi$	Half-width $[\Delta f_{\text{noise}}/^2]$ vs f_F	$(n\times n)$ $\int_0^\infty r_0(t)^2 dt$	$(s\times n)$ $\int_0^\infty r_0(t)dt$
Rectangular	$W(f) = 0, f > f_0 + f_F$ $f < f_0 - f_F$ $= W_0, f_0 - f_F < f$ $< f_0 + f_F$	$\frac{\sin\omega_F t}{\omega_F t}$	$\frac{W_0\omega_F}{\pi}$	$f_F = \frac{\Delta f_n}{2}$	$\frac{\pi}{2\omega_F}$	$\frac{\pi}{2\omega_F}$
Gaussian	$W(f) = W_0 e^{-(\omega-\omega_0)/\omega_F^2}$	$e^{-\omega_F^2 t^2/4}$	$\frac{W_0\omega_F}{2\sqrt{\pi}}$	$f_F = 1.15\times\frac{\Delta f_n}{2}$	$\frac{1}{\omega_F}\sqrt{\frac{\pi}{2}}$	$\frac{\sqrt{\pi}}{\omega_F}$
"Optical"**	$W(f) = \frac{W_0}{1+\left(\frac{\omega-\omega_0}{\omega_F}\right)^2}$	$e^{-\lvert\omega_F t\rvert}$	$\frac{W_0\omega_F}{2}$	$f_F = \frac{\Delta f_n}{2}$	$\frac{1}{2\omega_F}$	$\frac{1}{\omega_F}$

* These spectra are normalized so that $n_F^2 = \psi$ is the same in all cases and W_0, the maximum spectral intensity, is likewise kept unchanged; ω_F is accordingly varied.

** This is equivalent to the selectivity curve of a single-tuned circuit.

where the parantheses ( ) apply downward in the order given by Table I; (14) is illustrated in Figs. (9–11) for the three types of if spectrum, respectively, by the curves for quadratic rectification. Note that, of the three, the optical spectrum, corresponding to a single-tuned circuit, gives the largest signal-to-noise ratio.

III. General Half-Wave Theory: Signal

We proceed now with the more difficult problem of the general half-wave detector. First let us consider the output signal; this may be obtained from the appropriate part of the correlation function after rectification, which contains only frequencies of the modulation, their harmonics, and the dc contribution from $(n\times n)$ and $(s\times n)$ products. From equations (3.3) of footnote reference 7 we find the expression to be

$$R_0(t)_{(s\times s)} = \frac{\beta^2\Gamma(\nu+1)^2}{4\Gamma(\nu/2)^2(\nu/2)^2}\left(\frac{\psi}{2}\right)^{\nu}\left\{{}_1F_1(-\nu/2;\,1;\,-p_1)\,{}_1F_1(-\nu/2;\,1;\,-p_2)\right\}_{av.}, \tag{15}$$

where p_1 is the instantaneous input signal-to-noise power ratio $p(t)$ at time t_0', and p_2 is this ratio at time t later. Specifically, $p(t)$ is here

$$\begin{aligned} p(t) &= (1+\lambda\cos\omega_A t)^2 s_F{}^2/n_F{}^2 \\ &= p(1+\lambda\cos\omega_A t)^2, \quad 0 \leqq \lambda \leqq 1. \end{aligned} \tag{16}$$

The quantity ${}_1F_1$ is the confluent hypergeometric function, some of whose more important properties are mentioned in Appendix III of footnote reference 7. The average, as in (4) and (8), is to be performed over all phases of the modulation. Observe that when $\nu=2$, (15) reduces to (4), the numerical factor $\frac{1}{4}$ appearing in the former because only half the wave is transmitted, and that subject to square-law rectification.

The direct determination of averages in (15) is very laborious in most instances. However, we can get around this difficulty by observing that the form of the dc output $s_v(t)$ with carrier modulation is the same as that of the dc without modulation, s_v, except that the former fluctuates, adiabatically compared with the if and higher frequencies. Analytically, this is equivalent to setting $p_1=p_2=p(t)$ in (15) and taking the square root; the result is

$$s_\nu(t) = \frac{\beta\Gamma(\nu+1)}{2\Gamma(\nu/2+1)}\left(\frac{\psi}{2}\right)^{\nu/2}\left\{{}_1F_1(-\nu/2;\,1;\,-p(t)) - 1\right\}, \tag{17}$$

exclusive of dc due to $(n\times n)$ products. The mean dc response (due to the signal) may be safely discarded since it is an unimportant part of the low-frequency output not passed by the video or audio filters. Expansion of $s_v(t)$ in a Fourier series yields

$$\begin{aligned} s_\nu(t) &= \sum_{l=-\infty}^{\infty} a_l e^{i\omega_A l t}, \quad \text{with} \\ a_l &= \frac{1}{T_0'}\int_{-T_0{}^{1/2}}^{T_0{}^{1/2}} s_\nu(t)e^{-i\omega_A l t}dt \end{aligned} \tag{18}$$

where T_0' $(=2\pi/\omega_A)$ is the period of the modulation. The rms amplitude of the lth component, which is under observation, is

$$s_a = \sqrt{2}\,|a_l| = \frac{\sqrt{2}}{T_0'}\left|\int_{T_0{}^{1/2}}^{T_0{}^{1/2}} s_\nu(t)e^{-il\omega_A t}dt\right|, \quad l \geqq 1. \tag{19}$$

Since we observe only one component, phase considerations are not important (not so if we look at a radar screen, for example, where phase relations between components of the modulation are essential for our information, which is obtained from the *envelope* of the disturbance). From (17) and (19), the rms audio signal amplitude may be written

$$s_a = \frac{\beta\Gamma(\nu+1)}{\sqrt{2}\,\Gamma(\nu/2+1)}\left(\frac{\psi}{2}\right)^{\nu/2}\left|\frac{1}{2\pi}\int_{-\pi}^{\pi}\left[{}_1F_1(-\nu/2;\,1;\,-p(\theta)) - 1\right]e^{-il\theta}d\theta\right|, \; l \geqq 1. \tag{20}$$

Instead of expanding the hypergeometric function, let us approximate in an ad hoc fashion, according to the procedure of footnote reference 2, part II, II(d), which consists in replacing the infinite series by a polynomial of two terms.[10] After this has been done and (16) has been used for $p(t)$, we obtain finally for the first harmonic $(l=1)$, which is of primary interest,

$$(\nu=1):\quad s_a = \frac{\beta\psi^{1/2}p\lambda}{\sqrt{4\pi}}\left(1 - 0.2289p^{1/2}[1+\lambda^2/4]\right), \qquad p(1+\lambda)^2 \leqq 10, \tag{21a}$$

$$(\nu=2):\quad s_a = \frac{\beta\psi p\lambda}{\sqrt{2}} \qquad p \geqq 0. \tag{21b}$$

Figs. 2 and 3 illustrate the variation of s_a when $p \leqq 2.5$ and λ takes on all permissible values, with $\nu=1$ or $\nu=2$. As we expect, for small signal-to-noise ratios the linear and quadratic responses are nearly the same, due to modulation suppression in the former case. There, the noise reduces the signal strength. However, as p increases, the noise in turn is progressively suppressed by the signal, and the audio signal amplitude becomes more nearly proportional to $s_F\lambda$, as compared to $s_F{}^2\lambda$

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[10] Details are available in Technical Report No. 45, Cruft Laboratory, Harvard University, Cambridge, Mass.

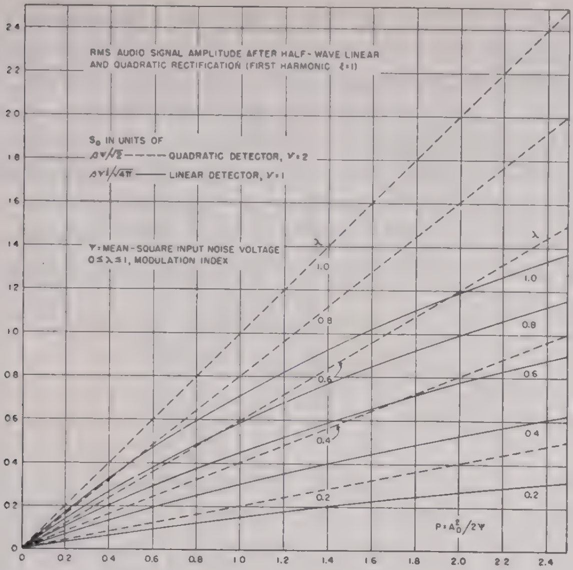

Fig. 2—Rms audio signal amplitude after half-wave linear or quadratic rectification as a function of $p=s_F^2/n_F^2$.

for the square-law device. These effects are naturally enhanced for the higher percentages of modulation, for then the signal is, on the average, greater by a factor $(1+\lambda^2/2)^{1/2}$.

When $p\rightarrow\infty$, our expression (20) for the rms audio signal is easily modified with the aid of the asymptotic form of ${}_1F_1$ (see A (3.3) of footnote reference 7) to give finally the important result for the first harmonic, namely,

$$s_a\Big|_{p\to\infty} \cong \frac{\beta\Gamma(\nu+1)\lambda\nu s_F^{\nu}}{2^{(\nu+3)/2}\Gamma(\nu/2+1)^2}\,{}_2F_1\left(\frac{1-\nu}{2},\ \frac{2-\nu}{2};\ 2;\ \lambda^2\right), \qquad (l=1), \tag{22}$$

and in particular, for the linear and quadratic detectors, (22) becomes

$$(\nu=1):\quad s_a\cong\frac{\beta\lambda s_F}{\pi};\qquad (\nu=2):\quad s_a\cong\frac{\beta\lambda s_F^2}{\sqrt{2}}\cdot \tag{23}$$

As we would expect, the noise is no longer effective in modifying the signal amplitude.

IV. General Half-Wave Theory: Noise

In order to obtain signal-to-noise ratios, we must determine the mean-square or the rms noise current or voltage passed by the detector and its associated filters. This is a more difficult problem for noise than for signals, since the mixing of the components of the modulation

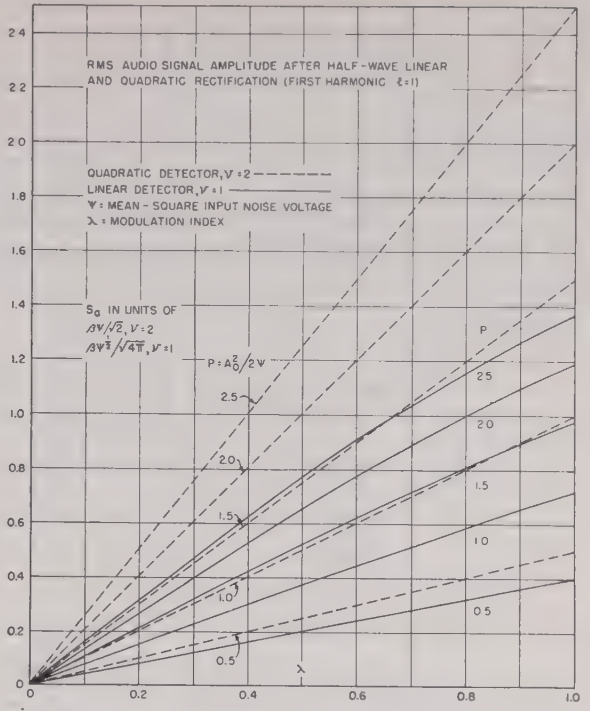

Fig. 3—Same as Fig. 2, as a function of the modulation index.

with those of the noise, as well as cross-modulation of the noise with itself, have to be calculated. The results themselves are more complex and less susceptible to facile approximation than those for the signal, although simplifying approximations may still be made, but these require a narrower range of values for such variables as the input signal-to-noise ratio p, and modulation index λ.

The low-frequency correlation function $R_0(t)$ for the noise output forms the starting point of this part of our analysis. Footnote reference 7 then enables us to write[11] the $(n\times n)$ part of the correlation function as

$$R_0(t)_{(n\times n)} = C_\nu^2\Bigg\{r_0(t)^2\big[{}_1F_1(1-\nu/2;1;-p_1)\,{}_1F_1(1-\nu/2;1;-p_2)\big]_{\text{av.}} + \Gamma(\nu/2)^2\sum_{q=2}^{\infty}\frac{\big[{}_1F_1(q-\nu/2;1;-p_1)\,{}_1F_1(q-\nu/2;1;-p_2)\big]_{\text{av.}}r_0(t)^{2q}}{(q!)^2\Gamma(1-q+\nu/2)^2}\Bigg\}, \tag{24}$$

and for the contribution arising from the beats between signal and noise

$$R_0(t)_{(s\times n)} = C_\nu^2\Bigg\{2r_0(t)\big[(p_1p_2)^{1/2}\,{}_1F_1(1-\nu/2;2;-p_1)\,{}_1F_1(1-\nu/2;2;-p_2)\big]_{\text{av.}} + \Gamma(\nu/2)^2\sum_{m=1}^{\infty}\sum_{q=1}^{\infty}\frac{2r_0(t)^{m+2q}\big[(p_1p_2)^{m/2}\,{}_1F_1(m+q-\nu/2;m+1;-p_1)\,{}_1F_1(m+q-\nu/2;m+1;-p_2)\big]_{\text{av.}}}{q!(q+m)!(m!)^2\Gamma(1-m-q+\nu/2)^2}\Bigg\} \tag{25}$$

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[11] The low-frequency correlation function follows at once from (3.3), footnote reference 7, when l is put equal to zero. Equation (4.4) ibid., with $b_0=0$ for the half-wave condition, gives us $H_{m,m+2q}$ if we let $n=m+2q$. The result is the correlation function consisting of $(n\times n)$ and $(s\times n)$ terms, the former appearing if $m=0$, $q\geqq1$, and the latter if $m\geqq1$, $q\geqq1$. The dc noise output is obtained when $m=q=0$.

where

$$C_\nu^2 = \frac{\beta^2\Gamma(\nu+1)^2}{4\Gamma(\nu/2)^2}\left(\frac{\psi}{2}\right)^\nu. \tag{26}$$

Observe that when $p\to\infty$, either because the signal relative to the noise is very large or the noise is vanishingly small while the signal remains constant in strength, the low-frequency correlation function assumes the following forms, in the important special cases of linear and quadratic rectification discussed here, specifically:

$$\begin{aligned}(\nu=1):\ R_0(t)_{(n\times n)} &\cong \frac{\beta^2\psi p^{-1}}{8\pi^2} r_0(t)^2 {}_2F_1(1;3/2;1;\lambda^2);\\ R_0(t)_{(s\times n)} &\cong \frac{\beta^2\psi}{\pi} r_0(t),\end{aligned} \tag{27a}$$

and

$$\begin{aligned}(\nu=2):\ R_0(t)_{(n\times n)} &\cong \frac{\beta^2\psi^2}{4} r_0(t)^2;\\ R_0(t)_{(s\times n)} &\cong \frac{\beta^2\psi^2 p}{4}(2+\lambda^2) r_0(t).\end{aligned} \tag{27b}$$

We notice from (24) and (25) that the $(n\times n)$ noise is *always* (all $\nu>0$) suppressed relative to the $(s\times n)$ disturbance, by a factor $p^{-1}(\lambda=0)$ at least.

When $\nu=2$, we have the familiar half-wave quadratic detector, for which (24) and (25) become particularly simple, namely, one-quarter of the first two terms of (4), respectively. In fact, when ν is even, (24) and (25) assume simple forms, since the various series terminate after $\nu+2-2m-2q\leqq 0$ terms; ν odd, however, is not so obliging. The series do not terminate, and we must investigate them to see in what way it may be possible to evaluate the averages and reduce the number of terms.

First, let us consider the case of no modulation, $p(t)=p$, when ν is odd and, in the most important instance, unity. Numerical examination of (24) when $t=0$ shows that the error is greatest (9.3 per cent) in omitting the series $(q\geqq 2)$ for small values of $p(<1)$, and that this error steadily decreases as $p\to\infty$. The limiting expression for (24) is

$$(\nu=1):\quad R_0(t)_{(n\times n)} \cong \frac{\beta^2\psi}{8\pi}\left\{\frac{r_0(t)^2p^{-1}}{\pi} + \sum_{q=2}^{\infty}\frac{\pi p^{1-2q}r_0(t)^{2q}}{(q!)^2\Gamma(3/2-q)^4}\right\}_{p\to\infty}, \tag{28}$$

indicating that on the whole the $(n\times n)$ contribution is suppressed as p^{-1}, $p\to\infty$, but that the higher terms $(q\geqq 2)$ go out at least p^2 as rapidly as the leading term $(q=1)$.

A similar analysis for (25) shows that in this instance the absolute error arising from the omission of the series $(m\geqq 1,\ q\geqq 1)$ starts at zero for $p=0$, increases to a maximum of about 0.09 at $p\sim 0.7$, and then falls off uniformly with increasing p. The limiting expression for (25) becomes

$$(\nu=1):\quad R_0(t)_{(s\times n)} \cong \frac{\beta^2\psi}{8\pi}\left\{\frac{8r_0(t)}{\pi} + \sum_{m=1}^{\infty}\sum_{q=1}^{\infty}\frac{2\pi p^{1-m-2q}r_0(t)^{2q+m}}{q!(q+m)!\Gamma(3/2-q)^2\Gamma(3/2-m-q)^2}\right\}_{p\to\infty}, \tag{29}$$

from which it is evident that the series terms, representing higher-order $(s\times n)$ modulation products, are suppressed at least as p^{-2} versus p^0 of the leading term. In other words, when $s_F{}^2$ exceeds $n_F{}^2$ $(=\psi)$ sufficiently, there is still noise in the low-frequency output, but this noise is directly proportional to the original noise leaving the if and quite independent of signal strength.

The total per cent error in omitting the series terms in $R_0(t)_{(n\times n)}$ and $R_0(t)_{(s\times n)}$ is found to be 8.5 per cent, or less, as p increases, in the instance of the mean noise power $(t=0)$, and is even smaller for the various spectra; for example, (<4 per cent) for the optical if when $p=0$. It has also been found that the error is somewhat reduced when there is modulation. In any case, for most purposes we see that it is quite safe to neglect the higher noise components $(m\geqq 0,\ q\geqq 2$, and $m\geqq 1,\ q\geqq 1)$. There then remains the calculation of the averages of the leading terms of (24) and (25). With modulation the exact treatment is also tedious but, fortunately, unnecessary for input signal-to-noise ratios less than about 2, as we may then approximate the hypergeometric functions in the leading terms in the same manner as was used for the signal (see Part III). Very large values of $p(t)$ permit us to use the asymptotic development in connection with (24) and (25), but for intermediate values there appears to be no escaping the direct development in moments $[p_1{}^{k_1}p_2{}^{k_2}]_{\text{av}}$. Again, fortunately, the region of greatest interest is usually that for which $p<2$.

Observing that we may set $t=0$ in p_2, i.e., $p_2=p_1=p(t_0')$ (but not in $r_0(t)$!), with negligible error, in the first terms of (24) (25), because $r_0(t)$ falls off to zero so rapidly when $t>0$ compared to $\cos\omega_A lt$, we obtain finally the correlation functions for the noise

$$\begin{aligned}(\nu=1):\quad R_0(t)_{(n\times n)} &\doteq C_\nu{}^2 r_0(t)^2\sigma_1(p,\lambda;\nu)\\ &\doteq C_1{}^2 r_0(t)^2\{1+2\alpha_1\overline{p}-2\gamma_1\overline{p^{k_1}}+\alpha_1{}^2\overline{p^2}+\gamma_1{}^2\overline{p^{2k_1}}-2\alpha_1\gamma_1\overline{p^{k_1+1}}\},\end{aligned} \tag{30}$$

and

$$\begin{aligned}(\nu=1):\quad R_0(t)_{(s\times n)} &\doteq C_\nu{}^2 r_0(t)\sigma_2(p,\lambda;\nu)\\ &\doteq C_1{}^2 r_0(t)2\{\overline{p}+2\alpha_2\overline{p^2}-2\gamma_2\overline{p^{k_2+1}}+\alpha_2{}^2\overline{p^3}+\gamma_2{}^2\overline{p^{2k_2+1}}-2\alpha_2\gamma_2\overline{p^{k_2+2}}\},\end{aligned} \tag{31}$$

with $p(t)_{\max} \leqq p$, the upper limit for which our approximation of the hypergeometric functions are valid.

In the specific instance of the sinusoidally modulated carrier, (16) describes $p(t)$, and from (2.30) of footnote reference 7 we observe that the average value of $p(t)^{\mu}$ becomes

$$\overline{p(t)^{\mu}} = p^{\mu}{}_2F_1(-\mu, -\mu + 1/2; 1; \lambda^2). \tag{32}$$

Then we may write, finally,

$$\begin{aligned}\sigma_1(p, \lambda; 1) = \{&1 - p(1 + \lambda^2/2) + 0.334p^{3/2}(1 + 3\lambda^2/2)\\ &+ p^2(1 + 3\lambda^2 + 3\lambda^4/8)/4\\ &- 0.167p^{5/2}(1 + 5\lambda^2 + 15\lambda^4/8)\\ &+ 0.0279p^3(1 + 15\lambda^2/2\\ &+ 45\lambda^4/8 + 5\lambda^6/16)\},\\ \sigma_2(p, \lambda; 1) = 2p\{&(1 + \lambda^2/2) - p(1 + 3\lambda^2 + 3\lambda^4/8)/2\\ &+ 0.131p^{3/2}(1 + 5\lambda^2 + 15\lambda^4/8)\\ &+ p^2(1 + 15\lambda^2/2 + 45\lambda^4/8 + 5\lambda^6/16)\\ &- 0.0327p^{5/2}(1 + 21\lambda^2/2 + 105\lambda^4/8\\ &+ 35\lambda^6/16) + 4.29\cdot 10^{-3}p^3(1 + 14\lambda^2\\ &+ 105\lambda^4/4 + 35\lambda^6/4 + 35\lambda^8/128)\},\end{aligned} \tag{33}$$

for the linear detector, and for the quadratic device we have simply

$$\sigma_1(p, \lambda; 2) = 1, \text{ and } \sigma_2(p, \lambda; 2) = p(2 + \lambda^2),\ p \geqq 0. \tag{34}$$

Figs. 4 and 5 illustrate σ_1 and σ_2 when $\nu = 1$, and Fig. 5 also shows $\sigma_2(p, \lambda, 2)$. In the linear rectifier the $(n \times n)$ noise is suppressed as the signal strength is increased, the more so for the lesser percentages of modulation. On the other hand, the $(s \times n)$ contribution increases with the larger signal powers, and the less is the increase for greater values of λ. Physically, this behavior is explained by the fact that, when the signal is large, the noise "rides" on top of it, so that for little modulation both positive and negative noise peaks are passed by the detector without much clipping due to cutoff. Greater percentages of modulation mean less noise voltage passed near the bottom of a modulation cycle; hence the decrease in $(s \times n)$ noise for $\lambda \sim 1$, or $\lambda = 0$. When $p \rightarrow \infty$, however, there is not much difference between noise outputs with 0 or 100 per cent modulation, as relatively little noise per (modulation) cycle is then blocked in either instance.

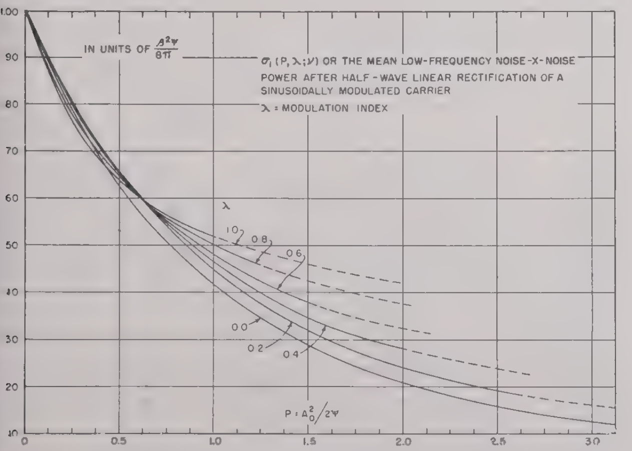

Fig. 4—Mean low-frequency output $(n \times n)$ noise power, for the linear rectifier.

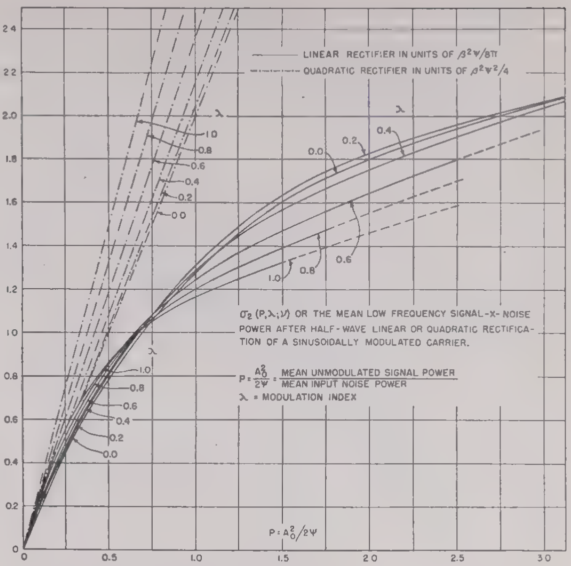

Fig. 5—Mean low-frequency output $(n \times n)$ noise power, for the linear and quadratic rectifiers.

Figs. 6 and 7 show the total mean low-frequency noise power, $\sigma_1 + \sigma_2$, when $\nu = 1$ and $\nu = 2$ for all degrees of modulation. Here again it is evident ($\nu = 1$) that even in the extreme case of $\lambda = 1$ modulation does not radically change the output noise power. This is important experimentally, because it allows us to measure the output noise separately from the signal, by injecting an *unmodulated* carrier into the if. The output then contains no signal contribution, the dc being filtered out. The noise power so determined may be substituted for the exact expression in the presence of modulation with an

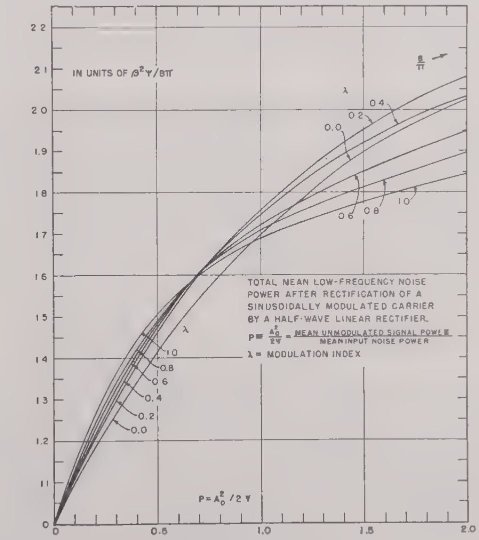

Fig. 6—Total mean low-frequency noise power output, $\nu = 1$.

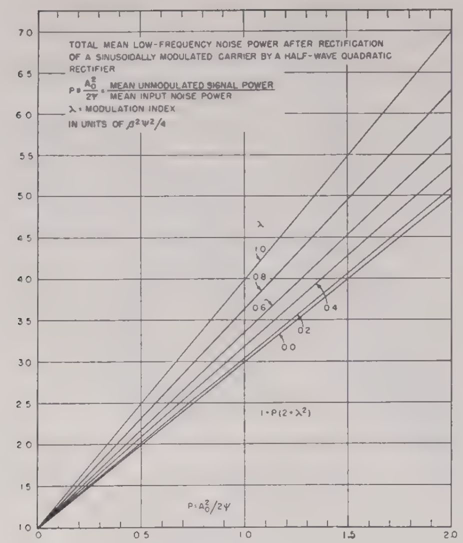

Fig. 7—Same as Fig. 6, but with $\nu=2$.

error of less than 10 per cent, an error which decreases as $p\rightarrow\infty$.

The full low-frequency power spectrum follows from (11), (30), (31), and (33), (34), namely,

$$W_0(f) \doteq C_\nu{}^2\left\{\sigma_1(p, \lambda; \nu)\int_0^\infty r_0(t)^2 \cos \omega t dt + \sigma_2(p, \lambda; \nu)\int_0^\infty r_0(t) \cos \omega t dt\right\}, \quad (35)$$

the first term representing $(n\times n)$ products, the second, $(s\times n)$ products; (35) is exact for $\nu=2$. The mean audio noise power may then be obtained from (35) in (8).

V. Audio Noise Power ($\nu>0$)

The mean noise power passed by our audio filter, of width Δf, is

$$n_a{}^2 \doteq \frac{\beta^2\Delta f\Gamma(\nu+1)^2}{\Gamma(\nu/2)^2}\left(\frac{\psi}{2}\right)^\nu\left\{\sigma_1\int_0^\infty r_0(t)^2dt + \sigma_2\int_0^\infty r_0(t)dt\right\}, \quad (36)$$

with different ranges of applicability for p and λ, depending on the value of ν; for $\nu=1$, $p(1+\lambda)^2$ is required to be less than 4, while for $\nu=2$, all values of p and λ are allowed. Now the physical significance of this quantity is conveniently brought out through an examination of its behavior for limiting values of signal strength, i.e., $p=0$, $p\rightarrow\infty$, and its dependence on if filter width at these values.

Let us consider first the linear rectifier and restrict ourselves to the case of no modulation ($\lambda=0$); the latter assumption embodies no real loss of generality, as the preceding section has shown that modulation has small effect ($\sim$10 per cent or less) on the output noise power when $\nu=1$. To obtain $n_a{}^2$ when p becomes very large we must use asymptotic forms for R_0 instead of (36); the result is

$$n_a{}^2\Big|_{p\rightarrow\infty} \cong \frac{4\beta^2\Delta f\psi\Gamma^{(1)}}{\pi^2\omega_F} = \frac{4\beta^2\Gamma^{(0)}\Gamma^{(1)}}{\pi^2} W_0\Delta f, \quad (37)$$

where $\Gamma^{(0)}$, $\Gamma^{(1)}$, and $\Gamma^{(2)}$ are numerical factors depending on the shape of the if. Specifically,

$$\left.\begin{aligned} \Gamma^{(0)} &\equiv \psi/W_0\omega_F = 1/\pi;\ 1/2\sqrt{\pi};\ 1/2 \\ \Gamma^{(1)} &\equiv \omega_F\int_0^\infty r_0(t)dt = \pi/2;\ \sqrt{\pi};\ 1 \\ \Gamma^{(2)} &\equiv \omega_F\int_0^\infty r_0(t)^2dt = \pi/2,\ \sqrt{\pi/2};\ 1/2 \end{aligned}\right\}, \quad (38)$$

for the rectangular, gaussian, and optical distributions, in that order (see Table I).

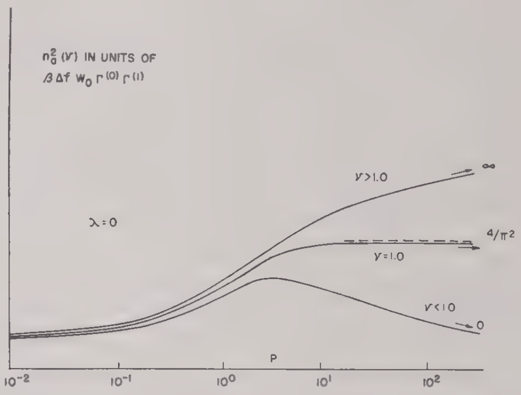

Fig. 8—Mean audio noise power output in the absence of modulation, for three different detector characteristics.

The expression (37) is approached monotonically and is the maximum value of the audio noise power, while the minimum value occurs for no signal at all and is, without the higher terms,

$$n_a{}^2\Big|_{p=0} = \frac{\beta^2\psi\Delta f\Gamma^{(2)}}{2\pi\omega_F} = \frac{\beta^2 W_0\Delta f\Gamma^{(0)}\Gamma^{(2)}}{2\pi}, \quad (39)$$

from (36). The physical explanation is as follows:

When the signal is negligible, the *envelope*, i.e., the low-frequency part of the rectified output, in which we are interested, is formed essentially of the positive peaks of the noise wave. When the signal is very large, the noise "rides" on it, and although only the positive portion of this mixture is passed by the detector, the noise can now fluctuate about its average, on either side, thus effectively doubling the deviation in amplitude of the resulting envelope. It is this deviation that forms the low-frequency voltage, after the dc has been removed. The effect becomes more pronounced as the signal is increased, until for huge signals there is no further gain, since the noise is now effectively lifted above the rectification level. The process is clearly monotonic. Thus the presence of the carrier adds progressively more $(s\times n)$ noise to the low-frequency, at the expense of power in the higher spectral zones centered about harmonics of the carrier, until the limit $p\rightarrow\infty$ is attained.

A similar argument holds when $\nu\neq1$. Here we have the more general results, from (36), (24), and (25), analogous to (37) and (39), that

$$p \to 0: \quad n_a{}^2(\nu) \doteq \frac{\beta^2\Gamma(\nu+1)^2 \Delta f W_0^{\nu} \Gamma^{(0)} \omega_F{}^{\nu-1} \Gamma^{(2)}}{2^{\nu}\Gamma(\nu/2)^2}, \qquad (n \times n). \tag{40}$$

$$p \to \infty: \quad n_a{}^2(\nu) \simeq \frac{\beta^2\Gamma(\nu+1)^2 \Delta f W_0 \Gamma^{(0)} \Gamma^{(1)} s_F{}^{2\nu-2}}{2^{\nu-1}\Gamma(\nu/2)^2\Gamma(\nu/2+1)^2}, \qquad (s \times n). \tag{41}$$

Now when $\nu<1$, the $(s\times n)$ noise is completely suppressed[12] $(s_F{}^2 \to \infty)$. The detector characteristic tends to "squash down" the higher peaks of the input wave, and consequently, as the signal is increased, the noise that rides on top is ironed out. When $\nu>1$, the reverse is true: the peaks are enhanced, the greater they and the signal amplitude are, and the $(s\times n)$ grows indefinitely. Equation (41) illustrates this and explains why, when $\nu>1$, one does not have a maximum. Fig. 8 shows the three cases, including $\nu=1$, discussed at the beginning of the section.

We observe further from (41) that for all values of ν the amount of noise is independent of the if spectral width $(\sim\omega_F)$, since it is only the immediate spectral vicinity of the carrier that contributes to the $(s\times n)$ noise which appears near $f=0$ in the output.

We have now to explain the behavior of the audio noise as a function of ω_F. Let us again consider the linear rectifier. Then, spreading the if spectrum, but keeping its intensity W_0 constant, does *not* increase the amount of noise near $f=0$, although at first glance one increases the number of closely adjacent noise products out on the added portions of the spectrum. However, we have neglected to take into account the "crowding effect," which is a consequence of the nonlinear action of the device, and which states that the products of adjacent frequencies near the center of the band outweigh in *intensity* those near its limits, although the number of such products is independent of frequency within the bandwidth. The result is that an increase in the if width simply increases the width of the low-frequency spectrum, but does not change the intensity near $f=0$. This is somewhat easier to understand on the basis of our earlier picture of the noise envelope. Doubling the spectral width merely increases the average and rms heights of the envelope by $\sqrt{2}$. The low-frequency (current or voltage) output is increased by the same factor and the low-frequency output power is doubled. The area of the power-spectrum triangle[13] is doubled, but since the envelope now varies twice as rapidly, the low-frequency power-spectrum triangle must now expand to twice its original value. Thus the area is doubled and consequently the intensity *near* $f=0$ must remain unchanged.[14]

We see also, from (40), that when $\nu<1$ the spectral ordinate near $f=0$ is actually decreased as ω_F is made larger, while the reverse is true when $\nu>1$, the latter a familiar result in the instance of the quadratic detector.

VI. Audio Signal-to-Noise Ratios: Discussion

The results of Sections III and IV now enable us to obtain a general expression of the rms audio signal-to-noise ratios, when the lth harmonic of the modulation is chosen as the signal to be observed. In the first case of chief interest, namely, the first harmonic after linear detection, we may write the ratio as

$$(\nu=1): \quad \frac{s_a}{n_a} = p\lambda\left[\frac{(\omega_F)_{\text{opt.}}}{2\Delta f}\right]^{1/2}\Bigg(1 - 0.2289p^{1/2}[1+\lambda^2/4] + \left[\left\{\begin{matrix}1\\ 1/\sqrt{2}\\ 1/2\end{matrix}\right\}\sigma_1(p,\lambda;1) + \left\{\begin{matrix}1\\ 1\\ 1\end{matrix}\right\}\sigma_2(p,\lambda;1)\right]\Bigg)^{-1/2}, \qquad p(1+\lambda)^2 \leqq 4 \tag{42}$$

where the quantities in the braces { } apply downward accordingly as the if has a rectangular, gaussian, or optical shape (see Table I and footnote). For the other important special case, quadratic rectification, our more general results are readily shown to reduce to (14) valid for all p and $\lambda \leqq 1$. Curves illustrating s_a/n_a as a function of p are given in Figs. 9–11 for the three types

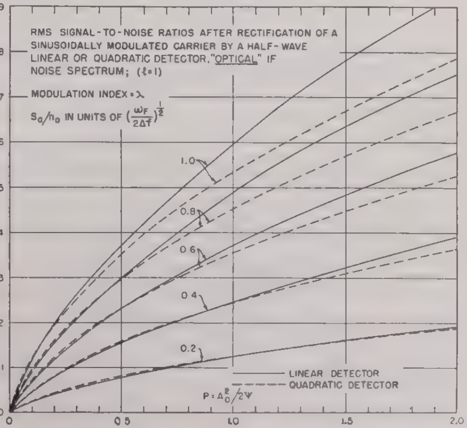

Fig. 9—Rms audio signal-to-noise ratios after half-wave linear or quadratic detection. Optical if filter.

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[12] As has been shown in Part IV, $(n\times n)$ noise is *always* suppressed more rapidly than the $(s\times n)$ products, by a factor p^{-1}, at least.

[13] We have assumed for simplicity that the if is rectangular and that $p=0$. A finite signal introduces no change in the essentials of the argument.

[14] Rice, in footnote reference 4, part IV, comes to the same conclusion, and by much the same train of thought.

of spectra mentioned above. Observe that the rectangular if gives the smallest, and the optical the largest value of s_a/n_a for a given p.

When the signal is small, we find for the general νth-law device that

$$\frac{s_a}{n_a}=\frac{p\lambda}{(2\Delta f)^{1/2}}\left(\int_0^\infty r_0(t)^2dt\right)^{-1/2}$$
$$=\frac{s_F{}^2\lambda}{W_0(2\Delta f\omega_F\Gamma^{(0)}\Gamma^{(2)})^{1/2}},\qquad \begin{matrix} p\ll 1,\\ l=1,\end{matrix}\tag{43}$$

which shows that in all cases the behavior is that of a quadratic rectifier, and is quite independent of ν. The reason for this lies in the aforementioned phenomenon of modulation suppression. Now, for small signals the background noise is hardly affected by the signal, and consists almost exclusively of $(n\times n)$ terms. However the signal is drastically affected by the noise, being reduced as the square of the input signal strength. Further, following precisely the same argument as that given in parts II, III, of footnote reference 2 for radar or pulsed signals, we can show that *the best if filter*, which makes s_a/n_a a maximum for a given input signal, *is one which is the modulus of the Fourier transform of the signal* —in this instance, three "delta-functions" or infinitely narrow pass-bands centered about the carrier and its two sidebands. Again, it is modulation suppression, arising from the nonlinearity of the detector, which dictates this kind of optimum if filter response, for without suppression one would need only an indefinitely narrow filter centered about one of the components.

For very large signals, we find with the aid of the asymptotic form for ${}_1F_1$ applied to (20), (24), and (25),

$$\frac{s_a}{n_a}\cong\frac{\lambda p^{1/2}}{\sqrt{2}(2\Delta f)^{1/2}}\frac{{}_2F_1(1/2-\nu/2,1-\nu/2;2;\lambda^2)}{{}_2F_1(1-\nu,3/2-\nu;1;\lambda^2)^{1/2}}\left(\int_0^\infty r_0(t)dt\right)^{-1/2}$$
$$=\frac{\lambda s_F\,{}_2F_1(1/2-\nu/2;1-\nu/2;2;\lambda^2)}{\sqrt{2}(2\Delta f)^{1/2}[\Gamma^{(0)}\Gamma^{(1)}W_0\,{}_2F_1(1-\nu,3/2-\nu;1;\lambda^2)]^{1/2}}.\tag{44}$$

Here only $(s\times n)$ products are significant, the if filter shape is unimportant, just as in the corresponding radar case, except for minor numerical terms ($\Gamma^{(0)}$, $\Gamma^{(1)}$, etc.), and so also is the law (ν) of the detector only secondarily significant. Note, however, for the continuous signals considered here, that the audio signal-to-noise ratio is proportional to $p^{1/2}$, while for pulsed signals this ratio becomes proportional to p. The explanation follows from the presence of $(s\times n)$ noise terms, which become dominant ($\sim p^{\nu-1}$ as $p\rightarrow\infty$) in the former instance, whereas in the radar example the signal is on such a small fraction of the repetition period that $(s\times n)$ products are ignorable and $(n\times n)$ components ($\sim p^{\nu-2}$ as $p\rightarrow\infty$ alone are the obscuring factor. Thus, as we would expect, the chief difference between the detection of pulsed and continuous signals only becomes apparent when $p>1$.

Special forms of (44) are

$$(\nu=1):\quad \frac{s_a}{n_a}\cong\frac{\lambda p^{1/2}}{\sqrt{2}}\left(\frac{\omega_F}{2\Delta f\Gamma^{(1)}}\right)^{1/2};$$
$$(\nu=2):\quad \frac{s_a}{n_a}\cong\frac{\lambda p^{1/2}}{\sqrt{2}}\left[\frac{\omega_F}{(2+\lambda^2)\Delta f\Gamma^{(1)}}\right]^{1/2},\tag{45}$$

and so we find that

$$\frac{(s_a/n_a)_{\nu=2}}{(s_a/n_a)_{\nu=1}}\cong\frac{1}{(1+\lambda^2/2)^{1/2}},\tag{46}$$

which can be observed in Figs. 9–11: the ratio for the quadratic detector is always reduced relative to the linear, due to a generation of a greater amount of $(s\times n)$ noise when $\lambda>0$ in the latter instance.

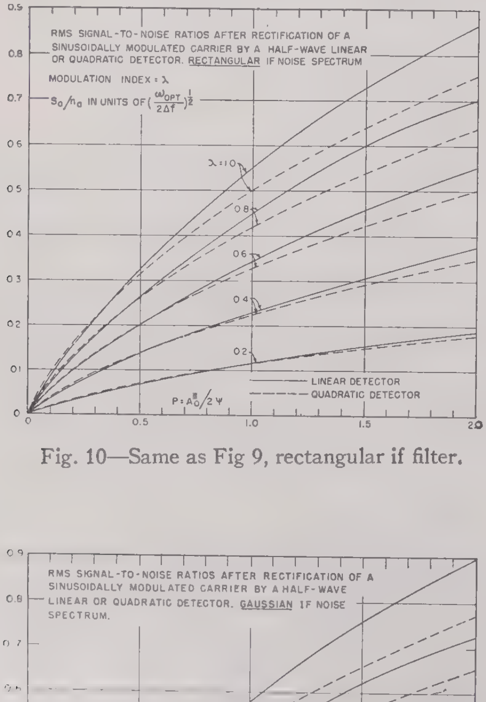

Fig. 10—Same as Fig 9, rectangular if filter.

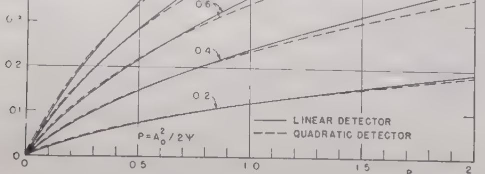

Fig. 11—Same as Fig. 9, gaussian if filter.

The results of this theory give a general picture of the relation between the signal at the output of a receiver as a function of the signal at the input of the if amplifier. For the purposes of making tests on the correlation between theory and experiment, it appears clear that the most useful type of detector, and therefore the one to be investigated, is the linear type.

In the companion paper[15] by Fubini and Johnson, the results of the theory for sinusoidal modulation and linear detection have been tested. The curves given in their paper are a replot of those presented here with a change in scale from linear to logarithmic co-ordinates. It appears in their work that, despite all the approximations made as to shape of if filter, linearity of rectification, and the like, the correspondence between theory and experiment is satisfactory for most practical purposes.

[15] E. G. Fubini and D. C. Johnson, "Signal-to-noise ratio in AM modulated receivers," Proc. I.R.E., vol. 36, pp. 1461–1467; this issue.

An Approximate Solution of the Problem of Path and Absorption of a Radio Wave in a Deviating Ionosphere Layer*

JAMES E. HACKE, JR.†, AND JOHN M. KELSO†

Summary—**A previously obtained double-parabola approximation to a Chapman distribution is used to obtain approximate solutions for ray path and absorption of a radio wave incident obliquely on a deviating plane ionospheric layer from which the wave is "reflected." The solutions, expressed analytically and graphically, are valid when the earth's magnetic field and second-order absorption effects can be neglected.**

INTRODUCTION

A PREVIOUS PAPER[1] proposed a double-parabola approximation to the Chapman distribution[2] which is generally accepted as representing variation of ion density with height in the E and the F_1 layers of the ionosphere. The paper also proposed a parabolic approximation for the product of ion density by electron-collision frequency as a function of height. By using these approximations, analytical solutions were obtained for "true" and apparent reflection height, and for absorption of a radio wave incident normally on the ionosphere. These solutions were also expressed in graphical form, and were compared with numerical results obtained by Pierce[3] and by Jaeger.[4]

The present paper extends the results of the previous paper to oblique incidence while retaining the restrictions that the wave frequency in the ionosphere be everywhere greater than the collisional frequency, that the effects of the earth's magnetic field be neglected, and that absorption per wavelength be small. These restrictions are met in practice for waves above about 1 Mc and correspond to consideration of the "ordinary" ray in quasi-transverse propagations.[5] Attention is confined to refraction and absorption in the deviating region (wave frequency insufficiently high to penetrate the layer) because an exact solution can be made of the problem when the ray penetrates the layer, at least if the ray can be considered as passing on essentially to infinity, and if the wave frequency is much greater than the critical frequency.

SUMMARY OF PREVIOUS RESULTS

In the previous paper[1] it was shown that the ion density in a Chapman region is given by

$$N = N_m Ch(x) \tag{1}$$

where

$$\begin{aligned} N_m &= \sqrt{(\beta S_\infty \sec \chi)/\kappa H \alpha \epsilon)} \\ Ch(x) &= \exp\,(1 - x - \epsilon^{-x})/2 \qquad (2) \\ x &= (h - h_0)/H - \ln \sec \chi \end{aligned}$$

α = the recombination coefficient in the ionosphere

ϵ = the base of Naperian logarithms

β = the ionization density produced by unit surface density of incident radiation

S_∞ = the surface density of radiation incident on the ionosphere

H = the "scale height" of the atmosphere in the region where the ionization is produced; division by H yields distances in "scale units"

h_0 = the height at which N is a maximum when $x = 0$

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[1] J. E. Hacke, Jr., "An approach to the approximate solution of the ionosphere absorption problem," Proc. I.R.E., vol. 36, pp. 724–727; June, 1948.

[2] S. Chapman, "The absorption and dissociative or ionizing effect of monochromatic radiation in an atmosphere on a rotating earth," *Proc. Phys. Soc.*, vol. 43, pp. 26–45; January, 1931.

[3] J. A. Pierce, "The true height of an ionosphere layer," *Phys. Rev.*, vol. 71, pp. 698–706; May, 1947.

[4] J. C. Jaeger, "Equivalent path and absorption in an ionosphere region," *Proc. Phys. Soc.*, vol. 59, pp. 87–96; January, 1947.

[5] H. G. Booker, "Some general properties of the formula of the magneto-ionic theory," *Proc. Phys. Soc.*, vol. 147, pp. 352–382; November, 1934.

χ = the sun's angular distance from the zenith.

Equation (2) was approximated by the two parabolas,

$$P_1(x) = 1 - x^2/T^2, \quad x_1 \angle x \angle 0; \qquad (3)$$

$$P_2(x) = A^2(x - x_2)^2, \quad x_2 \angle x \angle x_1. \qquad (4)$$

In these equations T, A, and x_2 are parameters adjusted to fit (2), and x_1 is the negative point of inflection of (2):

$$x_1 = -\ln(2 + \sqrt{3}) = -1.317$$

$$x_2 = x_1 - 4/(\epsilon^{-x_1} - 1) = -2.781$$

$$T = -x_1/\sqrt{1 - Ch(x_1)} = 1.848$$

$$A = (\epsilon^{-x_1} - 1)\sqrt{Ch(x_1)}/4 = 0.4792.$$

The index of refraction in an ionized layer is given by

$$\mu^2 = 1 - Ch(x)/R^2 \qquad (5)$$

where R is the ratio of wave frequency to vertical-incidence critical frequency; and the absorption per unit length is given by

$$K = K_m Ch(x)\epsilon^{-x}/(\mu R^2) \qquad (6)$$

where

$K_m = \nu_m/(2c)$

ν_m = the value of the collisional frequency ν at $x = 0$

c = the velocity of light in vacuum.

It is shown in the previous paper that

$$Ch(x)\epsilon^{-x} = P_3(x) \doteq a_0 + a_1 x + a_2 x^2, \quad x_3 \angle x \angle 0 \qquad (7)$$

where

$$a_0 = 0.7055; \quad a_1 = -2.382; \quad a_2 = -1.1696;$$

and

$$x_3 = -2.299 \text{ is the negative root of } P_3(x) = 0.$$

The ratios

$$N/N_m = Ch(x), \text{ and } N\nu/N_m\nu_m) = Ch(x)\epsilon^{-x},$$

are plotted in Fig. 1 as functions of x. Shown dotted are the parabolic approximations P_1, P_2, and P_3.

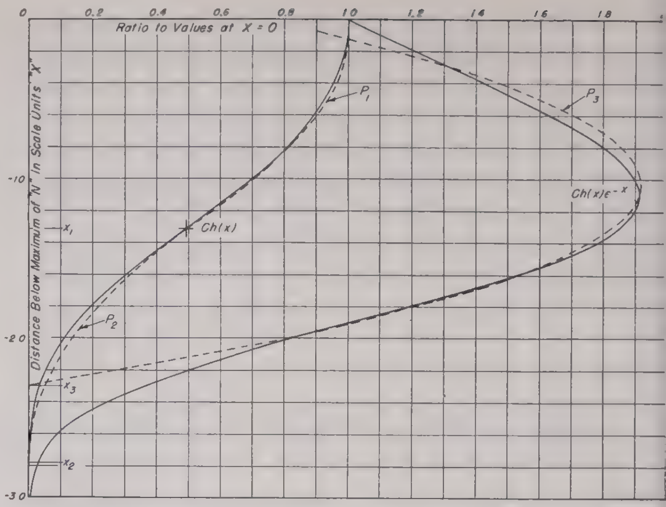

Fig. 1—Ion density and its product with collision frequency as functions of height in scale units below point of maximum ion density. Solid curves, Chapman distributions; dashed curves, parabolic approximations.

RAY PATH

Fig. 2 depicts an upgoing radio wave entering a plane ionized layer at an initial angle θ_0 with the vertical. The decrease of μ in the region deflects it away from the vertical; at a point x_0 its path becomes horizontal and the wave is said to be "reflected" at this point. The ray leaves the ionosphere at the same angle θ_0 with the vertical as that at which it enters.

By Snell's law,

$$(\sin\theta)/(\sin\theta_0) = 1/\mu \qquad (8)$$

where θ = the angle the ray makes with the vertical at any point on its path. This equation gives the angular direction of the ray path at any point in the region which the ray reaches, irrespective of the value of μ in intervening strata (on the downcoming half of the path, of course, θ is greater than $\pi/2$). From this equation,

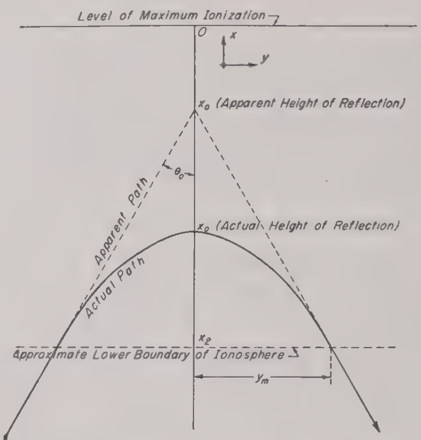
Level of Maximum Ionization
O
x
y
x_0 (Apparent Height of Reflection)
θ_0
Apparent Path
x_0 (Actual Height of Reflection)
Actual Path
x_2
Approximate Lower Boundary of Ionosphere
y_m

Fig. 2—Diagram illustrating ray path of radio wave through plane ionosphere.

$$dy/dx = \tan\theta = (\sin\theta_0)/\sqrt{\mu^2 - \sin^2\theta_0} \qquad (9)$$

where dy is horizontal displacement in scale units. From equation (5),

$$\begin{aligned} dy/dx &= (\sin\theta_0)/\sqrt{1 - Ch(x)/R^2 - \sin^2\theta_0}, \\ &= (R\sin\theta_0)/\sqrt{R^2\cos^2\theta_0 - Ch(x)}, \\ &= (R\sin\theta_0)/\sqrt{R'^2 - Ch(x)} \end{aligned} \qquad (10)$$

where $R' = R\cos\theta_0$ is the ratio of wave frequency to the critical frequency at angle of incidence θ_0.

When (3) and (4) are substituted in (10), the problem divides into three parts:

(i) Behavior in the upper region; the ray penetrates to the region ($x_1 \angle x \angle 0$) when R' is equal to or greater than 0.7015.

(ii) Behavior in the lower region ($x_2 \angle x \angle x_1$; $R' \angle 0.7015$) when reflection occurs in the lower region.

(iii) Behavior in the lower region ($x_2 \angle x \angle x_1; R' > 0.7015$) when reflection occurs in the upper region.

In Case (i), (9) becomes

$$dy = (R \sin \theta_0) dx/\sqrt{R'^2 - (1 - x^2/T^2)},$$
$$= (TR \sin \theta_0) dx/\sqrt{T^2(R'^2 - 1) + x^2}, \quad x_1 \angle x \angle x_0; \tag{11}$$
$$y - y_0 = (TR \sin \theta_0) \int_{x_1}^{x} dx/\sqrt{T^2(R'^2-1)+x^2},$$
$$= (TR \sin \theta_0) \ln \frac{x + \sqrt{T^2(R'^2-1)+x^2}}{x_1 + \sqrt{T^2(R'^2-1)+x_1^2}}, \quad x_1 \angle x \angle x_0 \tag{12}$$

where y_0 is defined later (see (15)).

The height of reflection x_0 can be found from (8), for the ray path must be horizontal at $x = x_0$, and therefore $\sin \theta$ must equal one. From (5) and (8),

$$\mu^2 = 1 - Ch(x_0)/R^2 = \sin^2 \theta_0;$$

substituting (3),

$$1 - (1 - x_0^2/T^2)/R^2 = 1 - \cos^2 \theta_0, \quad x_1 \angle x_0;$$
$$x_0 = -T\sqrt{1 - R'^2}, \quad x_1 \angle x_0. \tag{13}$$

If (13) be substituted in (12), one obtains

$$y - y_0 = TR \sin \theta_0 \ln \left[\frac{x + \sqrt{x^2 - x_0^2}}{x_1 + \sqrt{x_1^2 - x_0^2}} \right], \quad x_1 \angle x \angle x_0. \tag{14}$$

Choose y_0 so $y(x_0) = 0$:

$$-y_0 = TR \sin \theta_0 \ln \left[x_0/(x_1 + \sqrt{x_1^2 - x_0^2}) \right], \quad x_1 \angle x \angle x_0; \tag{15}$$

substituting in (14),

$$y = TR \sin \theta_0 \ln \left[(x + \sqrt{x^2 - x_0^2})/x_0 \right], \quad x_1 \angle x \angle x_0. \tag{16}$$

In numerical calculations the negative value of the square root of $x^2 - x_0^2$ is chosen in order that y increase with decreasing x_0^2. This same choice is also made in (21), (23), (25), and (30) for $\sqrt{x_1^2 - x_0^2}$.

In Cases (ii) and (iii), where it is the region ($x_2 \angle x \angle x_1$) that is being studied, (9) becomes

$$dy = R \sin \theta_0 dx/\sqrt{R'^2 - A^2(x - x_2)^2}, \quad x_2 \angle x \angle x_1; \tag{17}$$
$$y - y_0 = R \sin \theta_0 \int_{x_2}^{x} dx/\sqrt{R'^2 - A^2(x-x_2)^2},$$
$$= (R/A) \sin \theta_0 \sin^{-1} \left[A(x - x_2)/R' \right], \quad x_2 \angle x \angle x_1. \tag{18}$$

In Case (ii) reflection occurs in the region ($x_2 \angle x_0 \angle x_1$), and the height of reflection is given by

$$\sin \theta(x_0) = 1 = \sin \theta_0/\mu(x_0);$$

from (5),

$$Ch(x_0)/R^2 = \cos^2 \theta_0;$$

substituting (4),

$$A^2(x_0 - x_2)^2 = R^2 \cos^2 \theta_0, \quad x_2 \angle x_0 \angle x_1;$$
$$x_0 = x_2 + R'/A, \quad x_2 \angle x_0 \angle x_1. \tag{19}$$

In this case we again define y_0 so $y(x_0) = 0$, and obtain from (18)

$$-y_0 = (R/A) \sin \theta_0 \sin^{-1} 1$$
$$= (R/A)(\pi/2) \sin \theta_0, \quad x_2 \angle x_0 \angle x_1;$$

and since

$$\pi/2 - \sin^{-1} u = \cos^{-1} u,$$

(18) becomes

$$y = (R/A) \sin \theta_0 \cos^{-1} \left[A(x - x_2)/R' \right], \quad x_2 \angle x \angle x_0 \angle x_1. \tag{20}$$

In Case (iii), when reflection occurs in the upper region, then the value of $y(x_1)$ given by (18) must equal the value of $y(x_1)$ given by (16):

$$y_0 + (R/A) \sin \theta_0 \sin^{-1} \left[A(x_1 - x_2)/R' \right]$$
$$= -TR \sin \theta_0 \ln \left[(x_1 + \sqrt{x_1^2 - x_0^2})/x_0 \right], \quad x_1 \angle x_0;$$
$$y_0 = R \sin \theta_0 \left[T \ln \frac{x_1 + \sqrt{x_1^2 - x_0^2}}{x_0} - \frac{1}{A} \sin^{-1} \frac{A(x_1 - x_2)}{R'} \right], \quad x_1 \angle x_0;$$

and (18) becomes, for this case,

$$y = (R/A) \sin \theta_0 [\sin^{-1} A(x - x_2)/R'$$
$$- \sin^{-1} A(x_1 - x_2)/R'$$
$$+ AT \ln (x_1 + \sqrt{x_1^2 - x_0^2})/x_0], \quad x_2 \angle x \angle x_1 \angle x_0. \tag{21}$$

The quantity $y/(R \sin \theta_0)$ is a function only of R' and x, under all three cases

(i) $x_1 \angle x \angle x_0$—see (13) and (16);
(ii) $x_2 \angle x \angle x_0 \angle x_1$—see (20);
(iii) $x_2 \angle x \angle x_1 \angle x_0$—see (21).

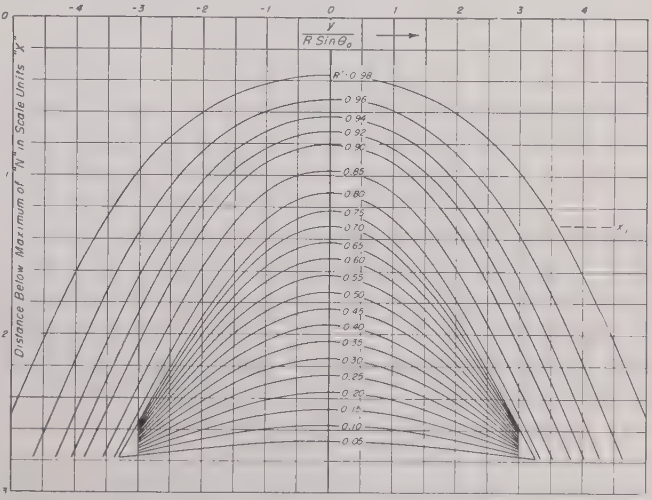

Fig. 3—Ray paths in the ionosphere with R' as a parameter. Ordinates are in units of $y/(R \sin \theta_0)$. See text for notation.

Fig. 3 shows the paths of radio waves through the ionosphere with R' as a parameter. Horizontal distances on the graph must be multiplied by $HR \sin \theta_0$ to obtain physical distances; vertical distances by H. The origin of the graph is at the level of maximum ionization directly above the point of reflection.

The horizontal range in the ionosphere $2y_m$ can be approximated by

$$y_m = y(x_2);$$

from (16) and (21),

$$\begin{aligned} y_m &= (\pi/2)(R/A)\sin\theta_0, \quad x_0 \angle x_1; && (22)\\ &= (R/A)\sin\theta_0[AT \ln(x_1+\sqrt{x_1^2-x_0^2})/x_0 \\ &\quad - \sin^{-1}(x_1-x_2)/R'], \quad x_1 \angle x_0. && (23) \end{aligned}$$

The apparent height of reflection x' (see Fig. 2) is given by extrapolating the path directions (upgoing and downcoming) at $(x_2, \pm y_m)$ until they meet at x', 0). From geometry, then,

$$\begin{aligned} x' &= x_2 + y_m \cot\theta_0, \\ &= x_2 + (\pi/2)(R'/A), \; H_0 \subset H_1: && (24)\\ &= x_2 + (R'/A)[AT\ln(x_1+\sqrt{x_1^2-x_0^2})/x_0 \\ &\quad - \sin^{-1}(x_1-x_2)/R'], \quad x_1 \angle x_0. && (25) \end{aligned}$$

The actual and the apparent heights of reflection are plotted in Fig. 4 as a function of R'.

When Martyn's equivalent path theorem[6] is put in the notation of this paper, it takes the form

$$x'(R', \theta_0) = x'(R, 0).$$

In words, the apparent height of reflection at oblique incidence is the same function of R' as the apparent height of reflection at vertical incidence is of R. This also applies to the actual height of reflection:

$$x_0(R', \theta_0) = x_0(R, 0).$$

These two relations can be verified by comparing (24) and (25) of this paper with (17) of footnote reference 1.

ABSORPTION

The reflection coefficient ρ is given by

$$\rho = \exp\left(-2\int_{-\infty}^{x_0} K ds\right). \qquad (26)$$

Let us define the absorption

$$S = \int K ds; \qquad (27)$$

the value of K is given by (6), and that of $\vec{ds}$ by

$$ds = H\sqrt{(dx)^2 + (dy)^2}.$$

Substituting from (9),

$$\begin{aligned} ds &= H\sqrt{(dx)^2 + \sin^2\theta_0(dx)^2/(\mu^2-\sin^2\theta_0)}, \\ &= H\mu dx/\sqrt{\mu^2-\sin^2\theta_0}; \end{aligned}$$

and (27) becomes, substituting from (6),

$$\begin{aligned} S &= \int [K_m Ch(x)\epsilon^{-x}/(\mu R^2)][H\mu dx/\sqrt{\mu^2-\sin^2\theta_0}], \\ &= (K_m H/R^2)\int Ch(x)\epsilon^{-x}dx/\sqrt{\mu^2-\sin^2\theta_0}. && (28) \end{aligned}$$

The product of the numerator, $Ch(x)\epsilon^{-x}$, is approximated by (7) in the region $x_3 \angle x \angle 0$. As in the determination of path, three cases must be distinguished in the absorption problem:

(i) Absorption in the region $(x_1 \angle x \angle 0)$ which occurs when R' is greater than 0.7015.

(ii) Absorption in the region below x_1 when R' is less than 0.7015.

(iii) Absorption in the region below x_1 when R' is greater than 0.7015.

In Case (i), μ^2 is approximated by

$$\mu^2 \doteq 1 - P_1(x)/R^2, \quad x_1 \angle x \angle x_0;$$

and (28) becomes, for the absorption in the P_1 region,

$$S^{(i)} = \frac{K_m HT}{R}\int_{x_1}^{x_0} \frac{(a_0 + a_1 x + a_2 x^2)dx}{\sqrt{x^2 - x_0^2}}, \quad x_1 \angle x_0. \qquad (29)$$

(To this must be added the absorption $S^{(iii)}$ in the P_2 region (see (32)). Equation (29) yields three integrals of the form

$$\int dx/\sqrt{x^2-x_0^2}; \qquad \int x dx/\sqrt{x^2-x_0^2};$$
$$\int x^2 dx/\sqrt{x^2-x_0^2}.$$

Integration of these is straightforward; the result is

$$\begin{aligned} S^{(i)} &= -(K_m HT/R)[(a_0 + a_2 x_0^2/2)\ln x_0/(x_1+\sqrt{x_1^2-x_0^2}) \\ &\quad - (a_1 + a_2 x_1/2)\sqrt{x_1^2-x_0^2}], \quad x_1 \angle x_0. && (30) \end{aligned}$$

The negative sign in front of the right-hand member of this equation appears because of the choice of the

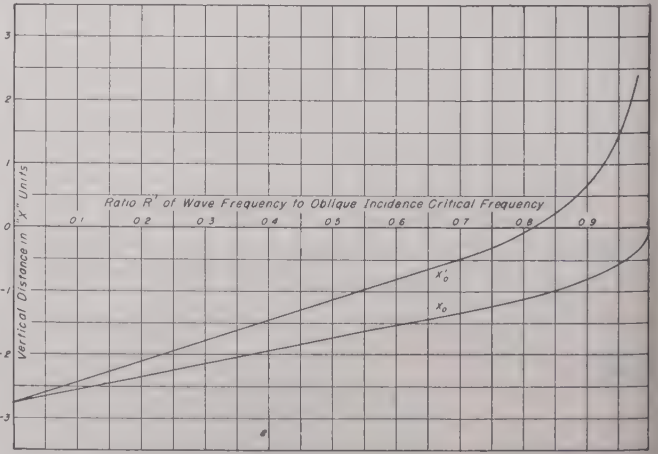

Fig. 4—Apparent and actual height of reflection in scale units below height of maximum ionization of a radio wave as a function of $R' = R\cos\theta_0$ = ratio of wave frequency to oblique-incidence critical frequency.

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[6] D. F. Martyn, "The propagation of medium radio waves in the ionosphere," *Proc. Phys. Soc.*, vol. 47, pp. 323–329; March, 1935.

negative square root of $x_1^2 - x_0^2$ as mentioned previously.

In Case (iii) (which is being considered before Case (ii) to complete the absorption $S^{(i)} + S^{(iii)}$ when R' is greater than 0.7015), the absorption $S^{(iii)}$ is given by

$$S^{(iii)} = (HK_m/R)\int_{x_3}^{x_1} P_3(x)dx/\sqrt{R'^2 - A^2(x - x_2)^2}, \qquad x_1 \angle x_0. \quad (31)$$

This can be transformed by a change of variable to three integrals of the form

$$\int du/\sqrt{R'^2 - u^2}; \qquad \int udu/\sqrt{R'^2 - u^2};$$

$$\int u^2du/\sqrt{R'^2 - u^2};$$

and the absorption in this region for this case is given by

$$\begin{aligned} S^{(iii)} = {} & [HK_m/(A^3R)]\{[A^2P_3(x_2) \\ & + a_2R'^2/2][\sin^{-1} A(x_1 - x_2)/R' \\ & - \sin^{-1} A(x_3 - x_2)/R'] \\ & + A[P_3'(x_2) + a_2(x_3 - x_2)/2] \\ & \cdot\sqrt{R'^2 - A^2(x_3 - x_2)^2} \\ & - A[P_3'(x_2) + a_2(x_1 - x_2)/2] \\ & \cdot\sqrt{R'^2 - A^2(x_1 - x_2)^2}\}, \quad x_1 \angle x_0 \end{aligned} \quad (32)$$

where

$$P_3(x_2) = a_0 + a_1x_2 + a_2x_2^2;$$
$$P_3'(x_2) = a_1 + 2a_2x_2.$$

When R' is greater than 0.7015, the total absorption is given by

$$S = S^{(i)} + S^{(iii)}, \quad x_1 \angle x_0. \quad (33)$$

In Case (ii), when R' is less than 0.7015, (31) with the upper limit changed to x_0 is the expression for $S^{(ii)}$. From (19),

$$x_0 - x_2 = R'/A, \quad x_2 \angle x_0 \angle x_1;$$

hence,

$$\sqrt{R'^2 - A^2(x_0^2 - x_2^2)} = \sqrt{R'^2 - A^2R'^2/A^2} = 0, \qquad x_2 \angle x_0 \angle x_1;$$

and

$$\sin^{-1} A(x_0 - x_2)/R' = \sin^{-1} AR'/R'A = \pi/2, \; x_2 \angle x_0 \angle x_1.$$

Also,

$$\pi/2 - \sin^{-1} u = \cos^{-1} u.$$

When the upper limit x_0 is substituted in (32) in place of x_1 and the above simplifications made, we have for reflection in the lower region

$$\begin{aligned} S^{(ii)} = {} & [HK_m/(A^3R)]\{[A^2P_3(x_2) \\ & + a_2R'^2/2] \cos^{-1} [A(x_3 - x_2)/R'] \\ & + A[P_3'(x_2) + a_2(x_3 - x_2)/2] \\ & \cdot\sqrt{R'^2 - A^2(x_3 - x_2)^2}\}, \quad x_3 \angle x_0 \angle x_1. \end{aligned} \quad (34)$$

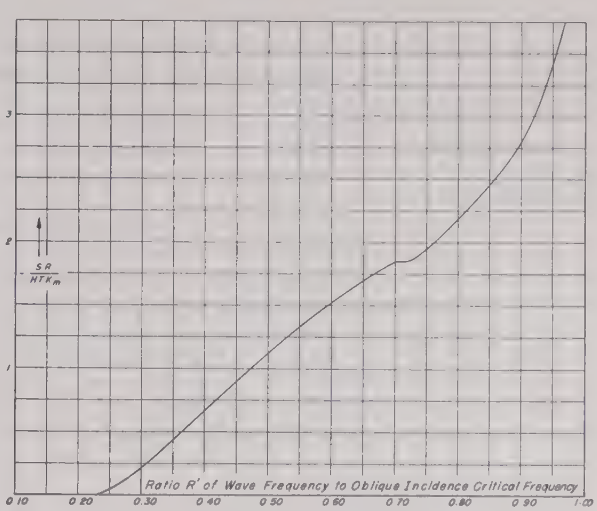

Fig. 5—Absorption as a function of R'. The quantity plotted is $-SR/(HTK_m)$. See text for notation.

Fig. 5 shows the value of $(SR)/(HTK_m)$ as a function of R'. The value of S can be found from the graph in a specific instance, knowing R, H, T, and K_m, and substituted for $\int Kds$ in (26).

Martyn's absorption theorem[6] states, in the present notation,

$$S(R', \theta_0) = (\cos \theta_0)S(R, 0);$$

this can be verified by comparison of (30), (32), and (34) of this paper with (22) and (23) of footnote reference 1.

CONCLUSIONS

Approximate ray path and absorption of a radio wave obliquely incident on the ionosphere can be calculated using the parabolic approximations obtained in footnote reference 1. The accuracy of these results are comparable to those obtained at vertical incidence.

In addition to the analytic approximations to the Chapman distribution, the following approximations have been made throughout this paper: (1) plane ionosphere; (2) collisional frequency in ionosphere much less than wave frequency; (3) no magnetic field; and (4) a quasi-homogeneous ionosphere, i.e., $(du/dx \ll \omega/c)$.

ACKNOWLEDGMENTS

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The Negative-Ion Blemish in a Cathode-Ray Tube and Its Elimination*

R. M. BOWIE†, FELLOW, IRE

Summary—This paper is a critical review of the widely scattered and somewhat conflicting data regarding negative ions in cathode-ray tubes and blemish formations.

The form of the ion blemish is a function of the form of focusing and scanning used, being a small central spot with electric focus and magnetic scan, and being a circle about an inch in diameter with magnetic focus and scan.

The blemish is due to chemical poisoning of fluorescence by negative ions formed on or near the cathode. The paths of such ions are substantially unaffected by the magnetic fields normally used with cathode-ray tubes. The path followed by an ion through an electric field is, however, the same as that of an electron starting from the same point of rest. Thus the ion blemish has the same shape as would the electron spot were the magnetic fields only removed from the crt. The use of a backing layer such as aluminum reduces the blemish but does not eliminate it, apparently owing to porosity of the backing layer. Such a layer has, however, other beneficial properties not related to the blemish problem.

The ion blemish can be eliminated by the use of an ion trap, which is a device usually located in or near the gun.

On THE SCREENS of certain types of cathode-ray tubes there appears, after some operation, a blemish which is particularly annoying when the tube is employed for television viewing. The form of the blemish depends upon the type of tube, but is usually a darkened area or spot with a rather well-defined boundary. In Fig. 1, the blemish spot is above the girl's left eyebrow. In the still picture it is rather unobtrusive, but when motion is present it becomes a source of considerable dissatisfaction among television set owners.

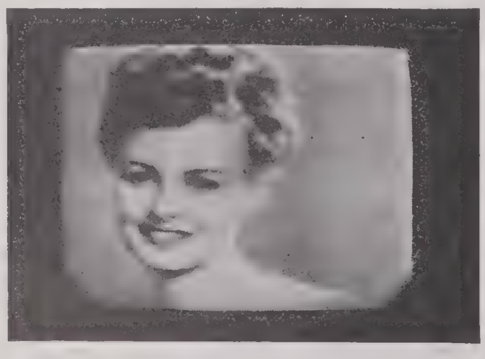

Fig. 1—Picture on the face of an electrically focused, magnetically scanned crt, showing ion blemish over the girl's left eyebrow.

This blemish is due to the localized reduction in the efficiency of light production, but is not visible under external illumination even when the bombarded side of the screen is examined. The blemish can take several forms, the form being determined by the focusing and scanning means employed. It will be shown later that most ions originate on or near the cathode, traverse the same paths as electrons through electrostatic fields, but are substantially unaffected by the magnetic fields used with cathode-ray tubes. Thus a tube employing an electrostatically focused gun and magnetic deflection usually develops, frequently in less than an hour of operation, a small blemish of the general shape and size of an undeflected spot. This is the most objectionable case. If, however, the tube is magnetostatically focused and employs magnetic scan, the resulting blemish has the same size and location as the undeflected "spot" seen with the focusing magnetic lens removed. In this case, the "spot" is a "shadow" of the limiting aperture in the gun, and is usually about an inch in diameter. This form of blemish develops more slowly because the ions are spread over a greater area. It appears after perhaps a hundred hours of operation and is particularly objectionable because of its well-defined boundary.

In a tube employing electrostatic focus and electric deflection, the electrons and ions are both focused into spots which are then scanned about the screen in the same way. The very-slowly forming ion blemish is therefore indistinguishable from the gradual loss in efficiency of the phosphor due to electron bombardment. It is possible to conceive of various other combinations of focusing and scanning means. The form of blemish which might develop can be predicted for each, but because of the lack of commercial importance, this will not be done here.

There are certain generally observed characteristics of the ion blemish. Its prominence decreases with increasing beam voltage. The potential at which it is no longer regarded as objectionable varies with the screen material, being about 12 to 15 kv for the sulfides. The rate of formation for a fixed viewing potential appears to be a decreasing function of beam voltage, also. Thus a tube operated for a short time at 1000 volts will have developed more blemish when viewed at 6 kv than it would have had it been operated for the same period at 6 kv.

The various screen materials have widely differing sensitivities to ion deterioration. Willemite is relatively insensitive to this effect, while zinc sulfide and zinc cadmium sulfide are highly sensitive. This fact points to the chemical poisoning of fluorescence by the ions as the cause of the ion blemish. In general, the susceptibility to ion blemishing appears to be related to the susceptibility of the phosphor to poisoning by impurities during manufacture.

Willemite, manganese-activated zinc orthosilicate, is

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compound requiring a relatively large concentration of ctivator ($\sim$1 per cent) and being relatively insensitive o poisoning of fluorescence by impurities such as nickel. The sulfides, which are usually activated with silver or opper, require activator concentrations of 0.01 per cent r less and are correspondingly more susceptible to poisoning of fluorescence by impurities.

Although the ion blemish has been ascribed by Sharpe[1] o the deposition of material on the surface of the phosphor crystals, which material slows the impinging electrons, the poisoning theory is much more tenable. To reduce the fluorescence the layer would have to have appreciable thickness. Data[2] reported for aluminum indicate that at 2 kv approximately 1000 molecular layers re required to reduce the beam power 20 per cent. If, as vill be shown later, the ions are chiefly oxygen, it is difcult to see how a sufficient thickness could be retained. Furthermore, Bachman and Carnahan[3] report that the negative ion blemish can be "developed" by immersing he face removed from a cathode-ray tube in photographer's "hypo." This points to some sort of chemical hange rather than to a film formation. It appears, however, that no explanation has been advanced in terms of hemistry of the solid state.

Nature and Origin of the Ion Beam

Several notable papers[3–5] have appeared dealing with he nature and origin of the negative-ion beams. The investigations reported involved mass-spectrographic nalyses of crt beams. In two cases,[3,4] standard or substantially standard cathode-ray tubes were employed as mass spectrographs by replacing the customary scanning coil with a strong electromagnet, and using the poisoning effect of the negative ions upon the screen to produce the records. The combined findings appear in Table I. In properly processed tubes, the predominant on is O_2^-. The two chlorine ions appear to be abundant also during early life, but substantially disappear in a ew hours of operation.

Both the origin of the ionizable material and the mechanism of ion formation are subject to some uncertainty. Three mechanisms appear to be involved, although several others have been considered and ruled out. These hree are: (1) emission of ions as such from the cathode; (2) ejection of ions from the cathode and grid by impact of positive ions formed by the electron beams; and (3) ion formation by attachment of electrons from the beam o gas molecules.

I. Emission of Negative Ions

With no exceptions, in a well-processed tube all negative ions appear to have their origins at or very near the cathode (or grid),[6–8] as the ion blemishes are well focused in electrically focused tubes. In certain magnetically focused tubes it is possible, with the magnetic lens removed, to form an electron image of the cathode surface on the screen. In such a tube Liebman[7] showed that this electron image agrees exactly in detail with the ion blemish, except for a few additional features.

Schaefer and Walcher[5] conclude from such observations as the independence of the O_2^- ion current on gas pressure that oxygen is emitted as ions. Broadway and Pearce[4] observed, however, that O^- ion spot formation is reduced by reduction of oxygen pressure. This, and the relatively poorer focus of the O^- spot, they took as evidence that oxygen is not emitted as ions. Both may be right. The former had cathodes operated under adverse conditions with high electrolytic conduction, apparently conducive to a surface reaction leading to O_2^- emission. The well-formed cathodes of the latter apparently emitted uncharged oxygen which contributed to the gas eventually ionized by electron attachment. Note that the oxygen ions reported are different in the two cases. Both papers agree, however, that chlorine is emitted as an ion.

Regardless of the exact mechanism of ionization, however, oxygen appears to originate from the well-known slow decomposition of the oxides of the cathode during operation. Chlorine may originate as an impurity in the cathode materials, although recently Hamaker, Bruining, and Aten[9] have reported evidence that it is due to the following chemical reaction in the glass during baking on exhaust:

$$2NaCl + H_2O + SiO_2 \rightarrow Na_2SiO_3 + 2HCl.$$

The NaCl is a common impurity, while H_2O is always present in commercial glass. The HCl reacts with BaO to yield $BaCl_2$ and H_2O. The former decomposes to yield Cl^- ions.

II. Negative-Ion Formation by Positive-Ion Bombardment

It has been shown that positive-ion bombardment of a surface usually yields spectra of negative ions much like those observed in cathode-ray tubes.[10–14] Bachman[6] was able to explain the ring-shaped spots previously observed[3] in certain purposely gassy tubes in terms of positive-ion bombardment of the grid aperture. The resulting negative-ion emission from the grid produced the ring-shaped ion blemishes observed for the oxygen. This theory was confirmed by notching the grid aperture and observing the "notch" in the ion-blemish circle, and also by noting grid-aperture erosion in dissected tubes. The heavy ions such as CaO^-, Ni, and BaO_2^- very possibly are due to positive-ion bombardment of the cathode surface.

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[1] J. Sharpe, "The ion trap in cr tubes," *Electronic Eng.*, (London) p. 385–386, December, 1946.

[2] D. W. Epstein and L. Pensak, "Improved cathode ray tubes vith metal-backed luminescent screens," *RCA Rev.* Vol. 7, pp. 5–8; March, 1946.

[3] C. H. Bachman, and C. W. Carnahan, "Negative ion components in the cathode-ray beam," Proc. I.R.E., vol. 26, pp. 529–539; May, 1938.

[4] L. F. Broadway, and A. F. Pearce, "Emission of negative ions rom oxide cathodes," *Proc. Phys. Soc.*, (London), vol. 51, pp. 335–348; 1939.

[5] Von H. Schaefer, and W. Walcher, "Negative ions in braun ubes and their relation to the oxide cathode mechanism," *Zeit. Phys.*, vol. 121, pp. 679–701; 1943.

[6] C. H. Bachman, "Ring focusing of negative ions in a cathode-ray beam," *Jour. Appl. Phys.*, vol. 11, pp. 83–85; January, 1940.

[7] G. Liebman, "Origin of ion burn in cathode-ray tubes," *Nature*, vol. 157, p. 228; February 23, 1946. Also, *Elec. Eng.*, vol. 18, pp. 289–290; September, 1946.

[8] H. A. Barton, "Negative ion emission from oxide coated filaments," *Phys. Rev.*, vol. 26, pp. 360–363; 1925.

[9] H. C. Hamaker, H. Bruining, and A. H. W. Aten, Jr., "On the activation of oxide-coated cathodes." *Philips Res. Rep.*, vol. 2, pp. 171–176; 1947.

[10] J. S. Thompson, "A new method of producing negative ions," *Phys. Rev.*, vol. 38, p. 1389; October, 1931.

[11] K. S. Woodcock, "The emission of negative ions under the bombardment of positive ions," *Phys. Rev.*, vol. 38, pp. 1696–1703; November 1, 1931.

III. Negative-Ion Formation by Electron Attachment

From gaseous-discharge research it is well known that electron attachment takes place only to electronegative molecules such as oxygen, and becomes relatively improbable at electron velocities above those corresponding to a few volts. Hence, attachment must occur very near the cathode. Approximate calculations of ion current by this process[4] yield low values, but do not rule out the method. As attachment to molecular oxygen may result in dissociation into O^- and O; the O^- found by Broadway and Pearce[4] very probably was produced by this attachment process.

The organic-vapor ions may be attributed to the breaking down of the cellulose-nitrate binder used in cathode preparation,[3] or to the presence of grease vapor as evidenced by the great number of such ions found by Schaefer and Walcher,[5] whose tube could not be baked out and had greased joints.

Blemish Elimination

It can be seen that the negative ions responsible for the blemish are chiefly O_2^- and Cl^- originating at or near the cathode. They are undeflected by magnetic fields employed with cathode-ray tubes, and reduce the low-voltage (<10,000 v) fluorescent efficiency of the screen material. To eliminate this defect, three approaches have been used. The first is to attempt to eliminate substances likely to form negative ions from the important parts of the tube by special care in parts preparation, followed by rigorous exhaust. In some cases, "getters" activated during operation have been employed to take up gas which might form ions. A hot tantalum filament in parallel with the cathode heater, and zirconium on gun parts, have been employed. It has been the author's experience, however, that such methods merely shift the blemish from an item of manufacturing shrinkage to a field complaint.

Backing Layer As Ion Filter

An interesting approach is to protect the screen with a filter relatively pervious to electrons, but impervious to ions. It is known[15] that the depth of penetration of a particle into a substance increases with particle velocity and decreases in proportion to particle mass. This indicates a strong discrimination by particle mass.

The application of a thin metallic backing layer has received considerable attention, primarily for three reasons other than the elimination of negative-ion blemishes.[16–20] First, an unbacked screen is brighter on the bombarded side because the light-producing interactions occur nearer that side. If a very thin metallic film is "stretched" relatively smoothly over the phosphor grains on the bombarded side of the screen, the brightness of the viewed side may be increased, provided that the loss of energy by the electrons in passing through the film is not too great. This is because the metal film reflects the back-directed light. In practice, the anode potential at which the brightness of a backed screen just equals that of a similar but unbacked screen is a function of backing-layer thickness and is of the order of a few kilovolts. Bachman[18] reports a value of 5 kv, which is presumed to apply for a tube intended for operation at 10 kv.

The second reason for the backing is the improvement of contrast by the elimination of the stray light from the bombarded side of the screen reflected from the inside walls of the tube. The third reason has to do with the provision of a conductive return path for the beam current; an unbacked screen relies upon secondary emission from the screen material to provide the path for the electron current in the beam to the second anode. The screen will not operate at a potential above which the secondary-to-primary current ratio drops below unity, which frequently occurs below 15 kv.

Means for obtaining backing layers are described by Law,[19,22] Schaefer,[20] and Bramley.[21] The aluminum backing currently in commercial use, while providing the advantages mentioned above, appears only to reduce the rate of ion-blemish formation.

Negative-Ion Trap

The third approach to the elimination of the negative-ion blemish is the use of the negative-ion trap, which separates the negative ions from the electrons in the

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[12] R. H. Sloane, and R. Press, "Formation of negative ions by positive ion impact on a surface," *Proc. Roy. Soc.*, vol. A168, pp. 284–300; 1938.

[13] F. L. Arnot, and Clark Beckett, "A new process of negative-ion formation IV," *Proc. Roy. Soc.*, vol. A168, pp. 103–122; 1938.

[14] R. H. Sloane, and Eliza Cathcart, "Formation of negative ions by negative-ion bombardment of surfaces, a new process," *Nature*, vol. 143, pp. 474–475; March 18, 1939.

[15] Beth, *Ann. der Phys.* vol. 5, p. 374; 1930.

[16] M. Von Ardenne, British Patent No. 402,411, accepted November 21, 1933.

[17] Kurt Schlesinger, U. S. Patent No. 2,209,639, issued February 4, 1936.

[18] C. H. Bachman, "Image contrast in television," *Gen. Elec. Rev.*, vol. 48, pp. 13–19; September, 1945.

[19] R. R. Law, U. S. Patent No. 2,233,786, issued March 4, 1941.

[20] Vincent J. Schaefer, U. S. Patent No. 2,374,311, issued April 24, 1945.

[21] Art Bramley, "Aluminum backed phosphor screen in cathode ray tubes," The Electrochemical Society Preprint 91–30; Meeting, April 9–11, 1947.

[22] R. R. Law, U. S. Patent No. 2,303,563, issued December 1, 1942.

eam. As has been pointed out by several authors,[3,4,23] n several different ways, the path followed by any harged particle through any purely electrostatic field s independent of mass-to-charge ratio, provided that all uch particles start from rest at the same point. If a nagnetostatic field is present, the path of a particle is ot independent of its mass-to-charge ratio. This latter rinciple is employed in the ion trap.

There are three features associated with the trap or ts operation. First, the charged particles are at least artially formed into a beam before reaching the trap. y this it is meant that by the time the ions and elecrons reach the vicinity of the trap, their trajectories hould form a bundle, the cross section of which does ot change greatly in a length equal to its diameter. econd, the beam is subjected to a magnetic field having component perpendicular to the beam length. Third, he ions are disposed of in a manner not to obstruct the assage of the electrons to the useful part of the screen.

The first form of ion trap with which the author had xperience[24] is that shown in Fig. 2 and Fig. 3, in which he gun is aimed at the edge of the screen and the vertial scanning coil is provided with strong, steady bias. It s obvious that the beam must be bent through a rather arge angle by the steady component of the magnetic ield in order that the ion blemish will fall outside of the canning raster. This results in considerable spot distorion. The tube[24] of Fig. 4 proved much more satisfactory from that standpoint, but presents manufacturing difficulties because of the nonaxial symmetry of the envelope. However, quite a number of such tubes have been made. This manufacturing disadvantage can be overcome by bending the gun in such a way that it will fit in a straight neck, as shown in Fig. 5. In this case, bending occurs before the beam electrons reach final velocity. A version of this arrangement, employing a magnetic lens, was used by Philco Radio and Television Corporation before the war.

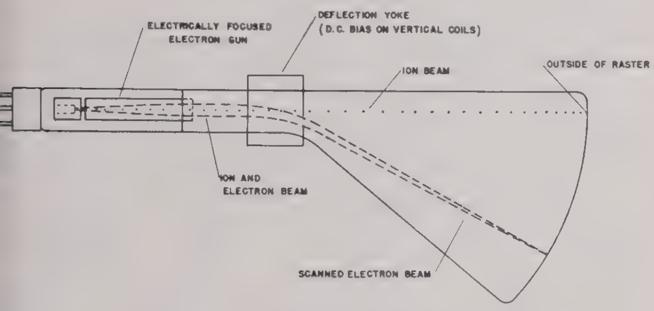
ELECTRICALLY FOCUSED ELECTRON GUN
DEFLECTION YOKE (D.C. BIAS ON VERTICAL COILS)
ION BEAM
OUTSIDE OF RASTER
ION AND ELECTRON BEAM
SCANNED ELECTRON BEAM

Fig. 2—An early ion-trap tube of the bent-beam variety, requiring excessive beam bending.

Fig. 3—Photograph of a tube of the type shown in Fig. 2.

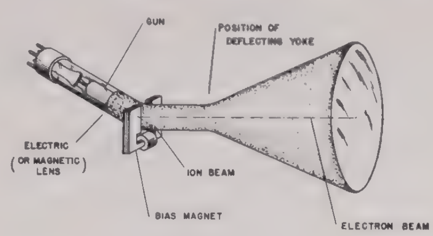
GUN
POSITION OF DEFLECTING YOKE
ELECTRIC (OR MAGNETIC) LENS
ION BEAM
BIAS MAGNET
ELECTRON BEAM

Fig. 4—Bent-neck variety of ion-trap tube employing the bent-beam principle.

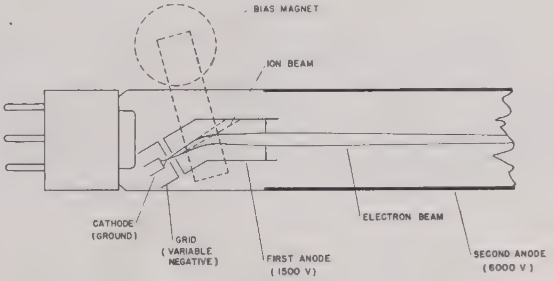
BIAS MAGNET
ION BEAM
CATHODE (GROUND)
GRID (VARIABLE NEGATIVE)
FIRST ANODE (1500 V)
ELECTRON BEAM
SECOND ANODE (6000 V)

Fig. 5—Bent-gun variety of ion trap employing the bent-beam principle.

H. Branson[25] described the gun shown in Fig. 6, in which the beam is focused and magnetically deflected so as to pass through a slightly off-center hole in the end of the extended second-anode cylinder.

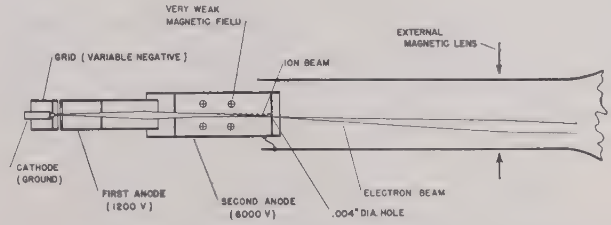
VERY WEAK MAGNETIC FIELD
EXTERNAL MAGNETIC LENS
GRID (VARIABLE NEGATIVE)
ION BEAM
CATHODE (GROUND)
FIRST ANODE (1200 V)
SECOND ANODE (6000 V)
.004" DIA. HOLE
ELECTRON BEAM

Fig. 6—The Branson[25] ion-trap gun.

In England, a type of crt employing an ion-trap gun due to Woodbridge[26] is manufactured by Electronic Tubes Ltd. The trap and gun are shown schematically in Fig. 7. Note that the cathode, the grid aperture, and the anode aperture are eccentric. The resulting field causes the entire beam to be deflected in the opposite direction to that which one might at first expect. At the

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[23] H. Busch, and E. Bruche, "Beitrage zur Elektronenoptik," ohann Ambrosius Barth; Leipzig, p. 34; 1937.

[24] R. M. Bowie, U. S. Patent Nos. 2,211,613 and 2,211,614.

[25] H. Branson, U. S. Patent No. 2,274,586, issued February 24, 1942.

[26] Leonard A. Woodbridge, British Patent Pending.

place where the beam crosses the gun axis, a magnetic field is provided which directs the electron beam along the axis, while the ions proceed to the stop in the anode.

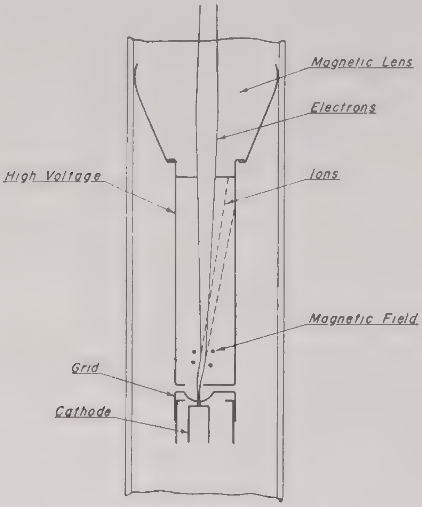

Fig. 7—The Woodbridge ion-trap gun.

The ion trap described above may be classed as of the bent-beam variety. Another class is that in which the electron beam is substantially unbent. This is accomplished by applying a transverse electric field with the magnetic field and of such a strength as to compensate the tangential force exerted by the magnetic field on the electrons. Such a trap was described by Bowie,[24] and is shown in Fig. 8. The transverse electric field bends the ion beam to one side, causing it to impinge upon the baffle, while the magnetic field counteracts the bending force on the electrons. A modification[27] of this unbent-beam trap is currently used in the type 10PB4[28] crt shown schematically in Fig. 9. The trap is so incorporated in the gun that no extra potential need be applied to the tube itself. By tilting the slot between grid No. 2 and the adjacent end of the anode, a component of electric field transverse to the gun axis is obtained. This component substantially compensates the action of the magnetic field upon the electrons. However, as the two fields do not compensate point-by-point along the axis, the electron beam deviates somewhat from the axis and is brought back by slightly overcompensating the electric field with one magnetic field, and then correcting the direction subsequently by means of a weak magnetic field in the opposite direction.

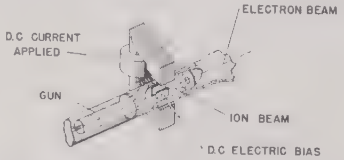

Fig. 8—Ion trap employing the undeflected-beam principle.

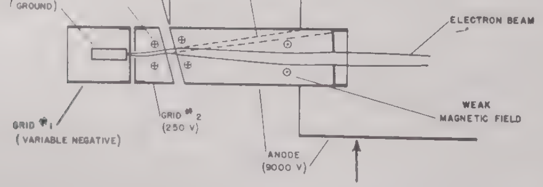

Fig. 9—Ion-trap gun of the type employed in the 10BP4, using the undeflected-beam principle.

CONCLUSIONS

The widespread use of magnetically deflected, directly viewed cathode-ray tubes operating below 10 kv in high-quality receivers has again pointed up the negative-ion-blemish problem which had received considerable attention before the war. The art has now progressed to the point at which the mechanisms of formation of the negative ions producing the spot are reasonably well understood, while means for reducing and for preventing the formation of the blemish are known.

ACKNOWLEDGMENT

The author wishes to thank G. D. O'Neill for his helpful suggestions in the preparation of this manuscript.

TABLE I

NEGATIVE IONS IN CRT BEAMS AS REPORTED BY BACHMAN AND CARNAHAN,[3] BROADWAY AND PEARCE,[4] AND SCHAEFER AND WALCHER[5]

Ion Mass	Bachman and Carnahan	Broadway and Pearce	Schaefer and Walcher, oxide cathode	Schaefer and Walcher, tungsten cathode
1		H	H strong	H strong
12	C	C		
13			CH_1 strong	
14			CH_2 strong	
16	O or CH_4	O		
17			OH strong	
18	OH_2		OH_2 weak	
19	F			
23			Na weak	
24			C_2 strong	
25			C_2H medium	
26	C_2H_2	$CN\text{-}C_2H_2$	C_2H_2 medium	C_2H_2 weak
30	NO			
32	O_2	O_2	O_2 strong	O_2 weak
33			?	
34			?	
35	Cl	Cl	Cl medium	
37	Cl	Cl	Cl medium	
40	Ca		Ca weak	
42		$CNO\text{-}C_3H_6$	? weak	
43			? weak	
48			? weak	
56	CaO		CaO weak	
58			Ni weak	
60			Ni weak	
62			? weak	
68			? weak	
74	$Ca(OH)_2$			
80		Br		
101	$CaCO_3$			
120	SrO_2			
127		I		
169	BaO_2			
261	$Ba(NO_3)_2$			

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[27] "Television receivers in mass production," *Electronics*, vol. 20, pp. 86–91; June, 1947.

[28] See RCA registration of crt type 10BP4, RMA Data Bureau, release no. 482, April 15, 1946; and of focusing coil, deflection yoke, and ion-trap magnet, release no. 661, May 13, 1948.

The Patterns of Slotted-Cylinder Antennas*

GEORGE SINCLAIR†, SENIOR MEMBER, IRE

Summary—**A method is described for calculating the patterns of arrays of axial-slot antennas mounted on the surface of a metallic cylinder. The method of calculation gives information on the relative phase of the radiated field in addition to the amplitude. Measurements have been made for certain of the antennas to verify the accuracy of the calculations. A number of calculated patterns are shown to indicate the extent of the control of the pattern which can be obtained by using arrays of slots on a cylinder.**

INTRODUCTION

ANTENNAS WHICH USE the radiating properties of slots in the surface of a metal cylinder are being used to an increasing extent for vhf and uhf applications. Slotted-cylinder antennas are particularly useful when it is desired to produce a horizontally polarized field with a horizontal pattern which is essentially circular. If the diameter of the cylinder is not too large, a single slot parallel to the axis produces a pattern which is usually sufficiently near a circle for most purposes. As the diameter of the cylinder is increased, the antenna becomes directional with a pattern which may have pronounced minima. While these directional properties can sometimes be utilized to secure more advantageous coverage of a given area, they are generally undesirable. It is, therefore, important to be able to predict the amount by which the pattern departs from a true circle.

As the number of stations using the higher frequencies increases, it is to be expected that there will be an increased demand for antennas with controlled directional patterns. Alford[1] has shown that a certain amount of control of the pattern of a slotted-cylinder antenna can be achieved by putting wings on the slots, but the amount of control which can be obtained is limited. Another method for modifying the pattern consists of using a number of slots spaced around the periphery of the cylinder. If the slots are equispaced around the periphery and fed in phase with equal amounts of power, the pattern can be made more nearly circular.[2] By feeding power of different amounts and different phases to the slots, a wide variety of patterns can be obtained.

Some data have been published on the patterns of slot antennas.[1,3] However, in order to design antennas consisting of arrays of slots, it is necessary to have available information on the variations in phase of the radiated field, in addition to information on the amplitude of the field. While it is possible to obtain this information from either full-scale or model measurements using well-known techniques, such a procedure is generally impractical because the necessary measuring equipment is not available to the antenna designer. Calculation of the pattern is a much more satisfactory procedure, and can be carried out quite readily.

CALCULATION OF THE PATTERNS OF SLOT ANTENNAS

The exact calculation of the field radiated by a slotted-cylinder antenna is a difficult boundary-value problem. However, the antenna designer is generally most interested in the horizontal pattern of a vertical slotted-cylinder antenna, and fortunately the calculation of this pattern is a much simpler problem. It can be shown that, when the breadth of the slot is small in comparison with the wavelength, the horizontal pattern is independent of the axial distribution of the field along the slot. By assuming the simplest possible axial distribution, namely, one in which the field is uniformly distributed in a slot which is infinitely long, an expression for the pattern can be obtained in the form of a Fourier series.[4]

In the following, only the horizontal patterns of vertical slotted-cylinder antennas will be considered. However, it is also possible to make approximate calculations of the vertical patterns, if certain simplifying assumptions are made.[1,3] Jordan and Miller[3] have shown that the vertical pattern of a vertical slotted-cylinder antenna is approximately the same as the corresponding pattern for a similar slot in a perfectly conducting plane sheet of infinite extent. This pattern can be approximated by calculating the H-plane pattern of the field radiated from the open end of a rectangular waveguide.[5]

PATTERN OF A SINGLE SLOT IN A CYLINDER

Fig. 1 shows the co-ordinate system employed in the calculation of the field, and also illustrates the notation used. The axis of the cylindrical surface coincides with the z axis of a cylindrical co-ordinate system. The slot is assumed to be parallel to the z axis, and located at $\phi = 0°$ on the surface of a cylinder of diameter $D = 2a$, a

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† Formerly, The Ohio State University Research Foundation; now, University of Toronto, Toronto, Ontario, Canada.

[1] A. Alford, "Long Slot Antennas," *Proc. Nat. Electronics Conf.*, Chicago, Ill., pp. 143–155; 1946.

[2] H. J. Riblet, "Microwave omnidirectional antennas," PROC. .R.E., vol. 35, pp. 474–478; May, 1947.

[3] E. C. Jordan and W. E. Miller, "Slotted-cylinder antennas," *Electronics*, vol. 20, pp. 90–93; February, 1947.

[4] G. Sinclair, E. C. Jordan, and E. W. Vaughan, "Measurement of aircraft-antenna patterns using models," PROC. I.R.E., vol. 35, pp. 1451–1462; December, 1947.

[5] S. A. Schelkunoff, "Electromagnetic Waves," D. Van Nostrand Co., Inc., New York, N. Y., 1943; p. 359.

being the radius. In the slot the field is assumed to be uniformly distributed axially, and polarized so that there is only an E_ϕ component. Thus, at the surface $\rho=a$, the field is assumed to be of the form

$$E_\phi = E_0\epsilon^{j\omega t} \quad \text{for } -\delta < \phi < \delta \tag{1a}$$

$$E_\phi = 0 \quad \text{for other values of } \phi \tag{1b}$$

where 2δ is the angular width of the slot in radians. It is assumed that the width of the slot is small, in comparison with the wavelength and with the diameter of the cylinder.

For these assumptions, it can be shown[4] that the field produced at a fixed large distance from the cylinder is a Fourier series

$$E_\phi \approx \frac{A}{j\pi}\left[a_0 + \sum_{n=1}^{\infty} a_n \cos n\phi\right] \tag{2}$$

where

$$a_0 = \frac{1}{2H_0^{(2)\prime}(ka)}$$

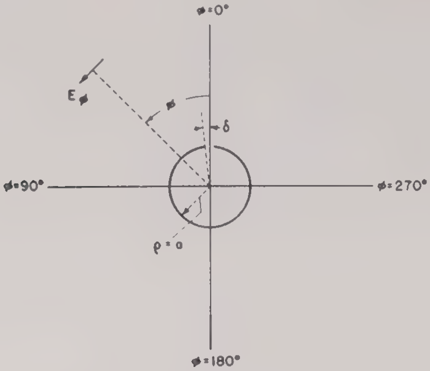
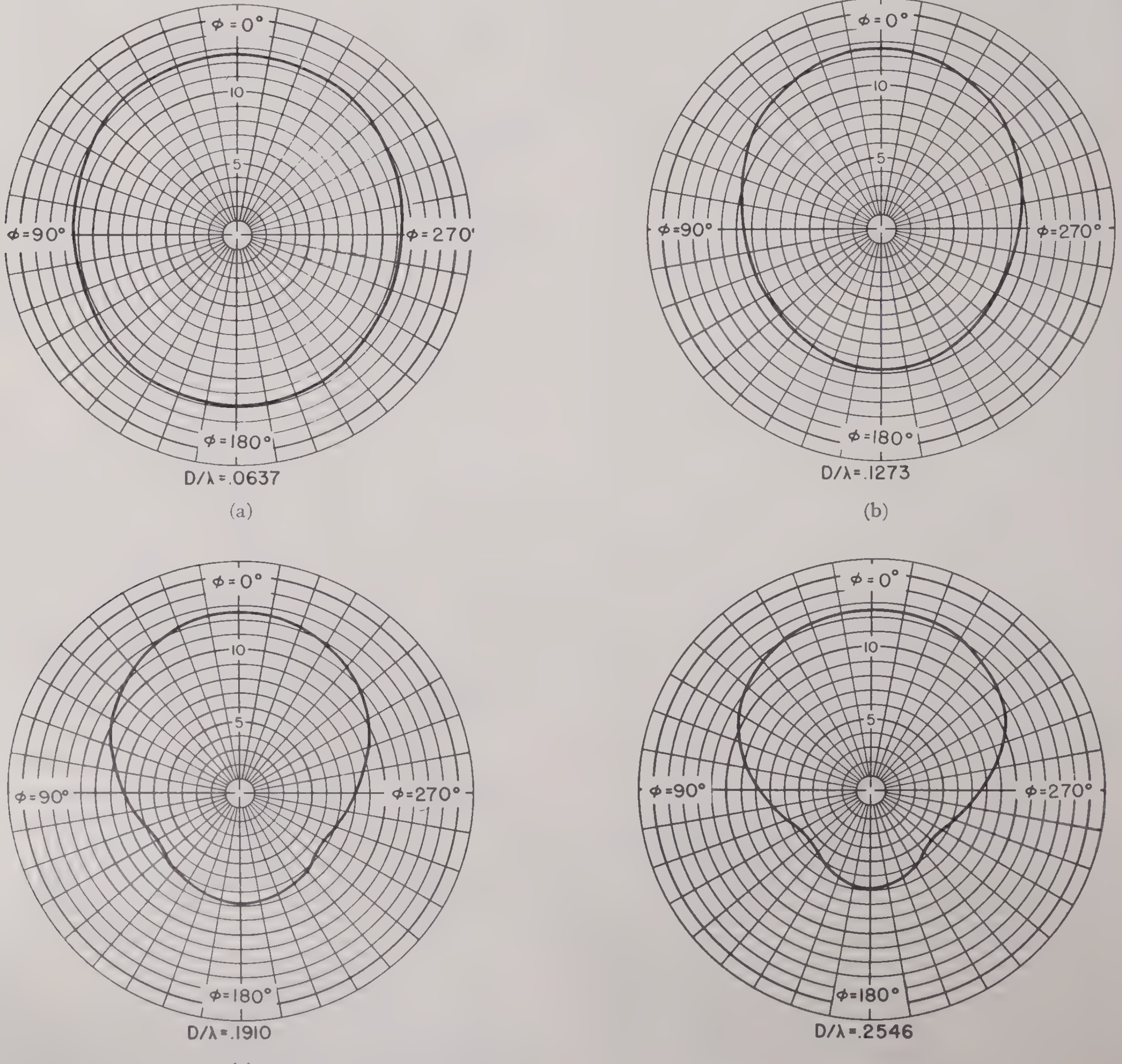


Fig. 1—Diagram showing the co-ordinate system.



D/λ=.0637 (a)

D/λ=.1273 (b)

D/λ=.1910 (c)

D/λ=.2546 (d)

Fig. 2—Patterns for a single slot in a cylinder. The slot is located at $\phi=0°$.

$$a_n = \frac{j^n}{H_n^{(2)\prime}(ka)}$$

$$ka = \frac{2\pi a}{\lambda}$$

λ = wavelength measured in same units as a.

The parameter A depends on the exciting voltage, and the distance from the antenna, but does not depend on the azimuth angle.[4] For calculating relative patterns, the value of A need not be known.

In (2), the coefficients a_n are complex, to take account of the phase variations in the field. The reference for phase in (2) is at the axis of the cylinder. The azimuth angle ϕ is measured from a reference line through the center of the slot (see Fig. 1).

AMPLITUDE AND PHASE PATTERNS FOR A SINGLE SLOT

Amplitude and phase patterns have been calculated, using (2), for a series of slotted-cylinder antennas of various diameters. Some of the amplitude patterns are shown in Fig. 2, and relative phase patterns in Fig. 3.

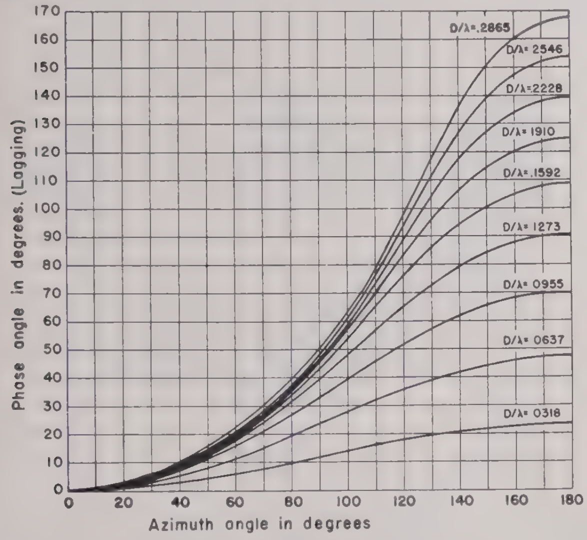


Fig. 3—Curves showing the variation in relative phase of the field with azimuth for a single slot in a cylinder. The slot is located at $\phi=0°$ in each case.

The patterns in Fig. 2 cannot be used to compare the gains obtained with the various antennas, since (2) does not give any information on gain, due to the assumptions made in deriving the equation. Hence, the patterns in Fig. 2 have been plotted to the same maximum value of relative field intensity in each case. The phase patterns in Fig. 3 show the phase of the field in a given direction, relative to the field at the same distance in the direction $\phi=0°$. The absolute phase computed from (2) has little significance for practical antennas, because of the large phase shifts which are unavoidably introduced by most feeding systems.

In order to verify the accuracy of the calculations of relative phase patterns, measurements were made on a slotted-cylinder antenna having a diameter of 0.1910

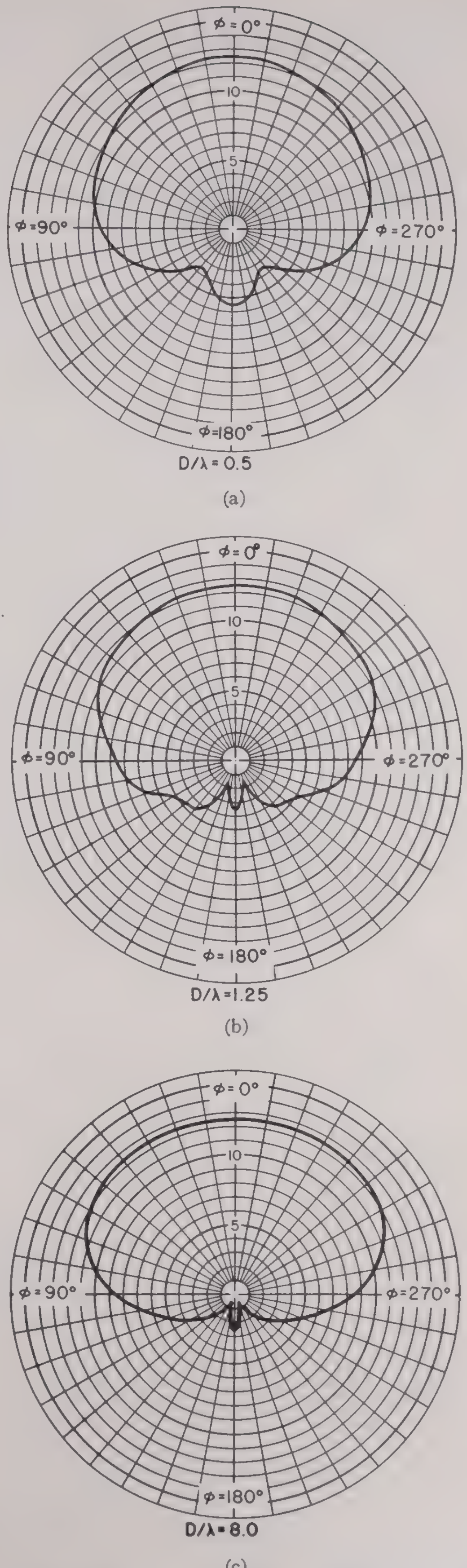


Fig. 4—The patterns of slotted-cylinder antennas having diameters large in terms of the wavelength. Slot is located at $\phi=0°$.

wavelength. The measurements were made for every 20° of azimuth. The maximum deviation of the measured values of phase from the calculated curve was ±5°.

SLOTTED CYLINDERS OF LARGE DIAMETER

Three patterns have been calculated for cylinders whose diameters are comparatively large in terms of wavelength. The patterns are shown in Fig. 4, and are for diameters of one-half, one and one-quarter, and eight wavelengths. It is apparent from these patterns that the effect of increasing the diameter is to reduce the signal in the region of the shadow cast by the cylinder. For cylinders of large diameter, the pattern is always approximately a cardioid.

THE PATTERNS OF ARRAYS OF SLOTS

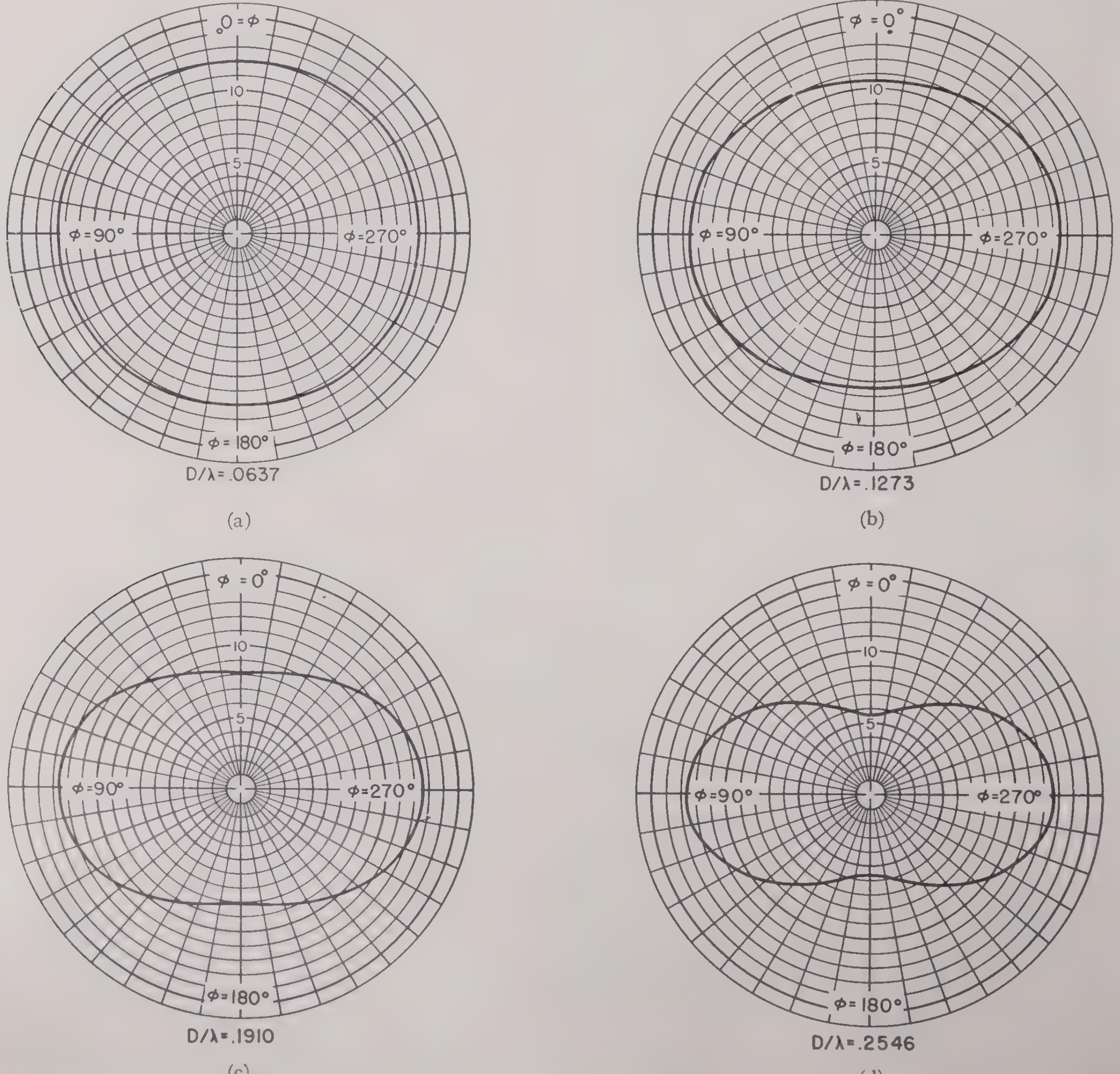
The patterns of arrays of slots can be computed by suitably combining, in the proper phases, the fields from the various slots, each calculated using (2). Since the reference for phase for each slot is at the axis of the cylinder, it is not necessary to introduce any phase factor involving the distance of each slot from the axis. Hence, the pattern of the array is found by simply superimposing the fields of each of the slots, taking due account of the relative amplitudes and phases of the power being fed to each slot.

Consider the situation when two slots are used, slot No. 1 being located at $\phi=0°$, and slot No. 2 at $\phi=\phi_2$. The field radiated by slot No. 1 is given by

$$E_{\phi_1} = \frac{A}{j\pi}\left[a_0 + \sum_{n=1}^{\infty} a_n \cos n\phi\right]. \tag{3}$$

Assume that slot No. 2 is fed in such a way that the field it produces is given by

$$E_{\phi_2} = \frac{MA}{j\pi}\left[a_0 + \sum_{n=1}^{\infty} a_n \cos n(\phi_2 - \phi)\right]e^{j\psi} \tag{4}$$



D/λ=.0637

(a)

D/λ=.1273

(b)

D/λ=.1910

(c)

D/λ=.2546

(d)

Fig. 5—Patterns for arrays of two diametrically opposed slots, fed equally and in phase. Slots are located at $\phi_1=0°$ and $\phi_2=180°$.

where M is the ratio of the amplitude of the field radiated in a given direction by slot No. 2 to the amplitude radiated by slot No. 1 in a similar direction from slot No. 1, and ψ is the time phase difference between these fields. If V_1 is the voltage fed to slot No. 1, and V_2 the voltage fed to slot No. 2, then

$$V_2 = Me^{j\psi}V_1. \tag{5}$$

The field produced by the array of the two slots is the sum of the fields in (3) and (4). The patterns of arrays of several slots can be obtained in a similar fashion.

AMPLITUDE AND PHASE PATTERNS FOR ARRAYS OF SLOTS

To illustrate some of the patterns which can be obtained from arrays, patterns have been calculated for arrays of two slots, the slots being located at opposite ends of a diameter and fed equally and in phase. Such arrays are of interest in that they are sometimes suggested as a means for obtaining patterns which are more nearly circular than the patterns for a single slot.

The patterns for the two-slot arrays are shown in Fig. 5, for the same diameters of cylinders used incomputing the patterns in Fig. 2. The relative phase patterns are shown in Fig. 6.

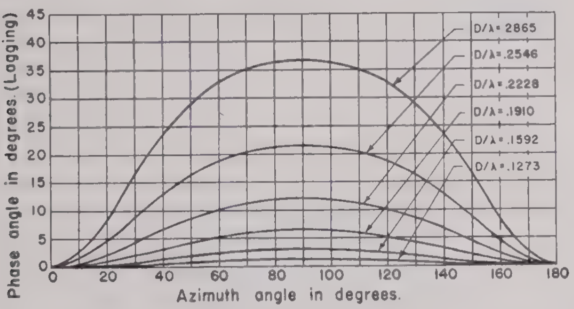


Fig. 6—Curves showing the variations in relative phase of the fields of arrays of two slots.

The ratios of the maximum to minimum field intensities in the patterns of Fig. 5 have been plotted in Fig. 7 as a function of cylinder diameter, for comparison with the corresponding ratios for a single slot. It is apparent that, for most diameters, two slots give some improvement in pattern over one slot. The improvement in phase is quite marked, as can be seen from Fig. 6. Fig. 7 also shows the maximum-to-minimum ratio for arrays of three slots, equispaced and fed equally and in phase. When four slots spaced 90° apart around the cylinder, are employed, the improvement in the maximum-to-minimum ratio is substantial for the range of diameters in Fig. 7.

Fig. 9 shows some patterns of arrays of two slots on a cylinder one-half wavelength in diameter. The pattern in Fig. 9(a) is for two slots diametrically opposed and fed equally and in phase, so that $\phi_2 = 180°$, $M = 1$, and $\psi = 0°$. Fig. 9(b) shows the pattern obtained when the phase of one of these slots is reversed ($M = 1$ and $\psi = 180°$).

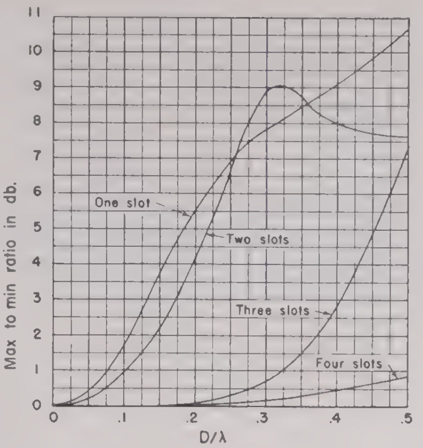


Fig. 7—Maximum-to-minimum ratio for the patterns of arrays of slots in cylinders.

It is apparent from the patterns in Fig. 9(a) and (b), and also from an examination of the manner in which (3) and (4) depend on ϕ, that when two diametrically opposed slots are used, the pattern must be symmetrical about the diameter through the slots. However, when the angle ϕ_2 between the slots is other than 180°, there will be, in general, no line of symmetry to the pattern. For example, with the arrangement of slots shown in Fig. 8, where $\phi_2 = 90°$, $M = 0.5$, and $\psi = 90°$, the pattern of Fig. 9(c) is obtained. Hence, in designing an antenna to produce a given asymmetrical pattern, it may be possible to achieve the desired pattern with only two slots.

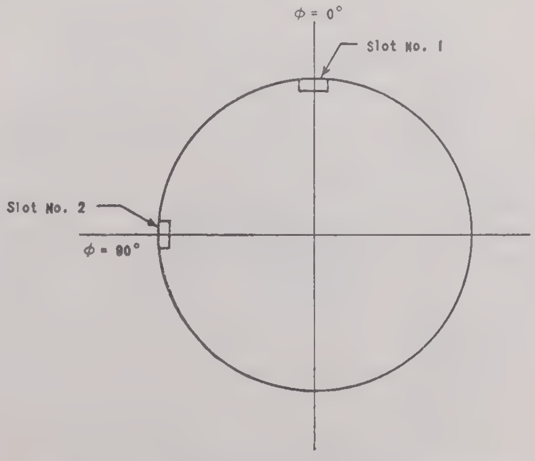


Fig. 8—Diagram showing the location of the slots for the pattern in Fig. 9(c).

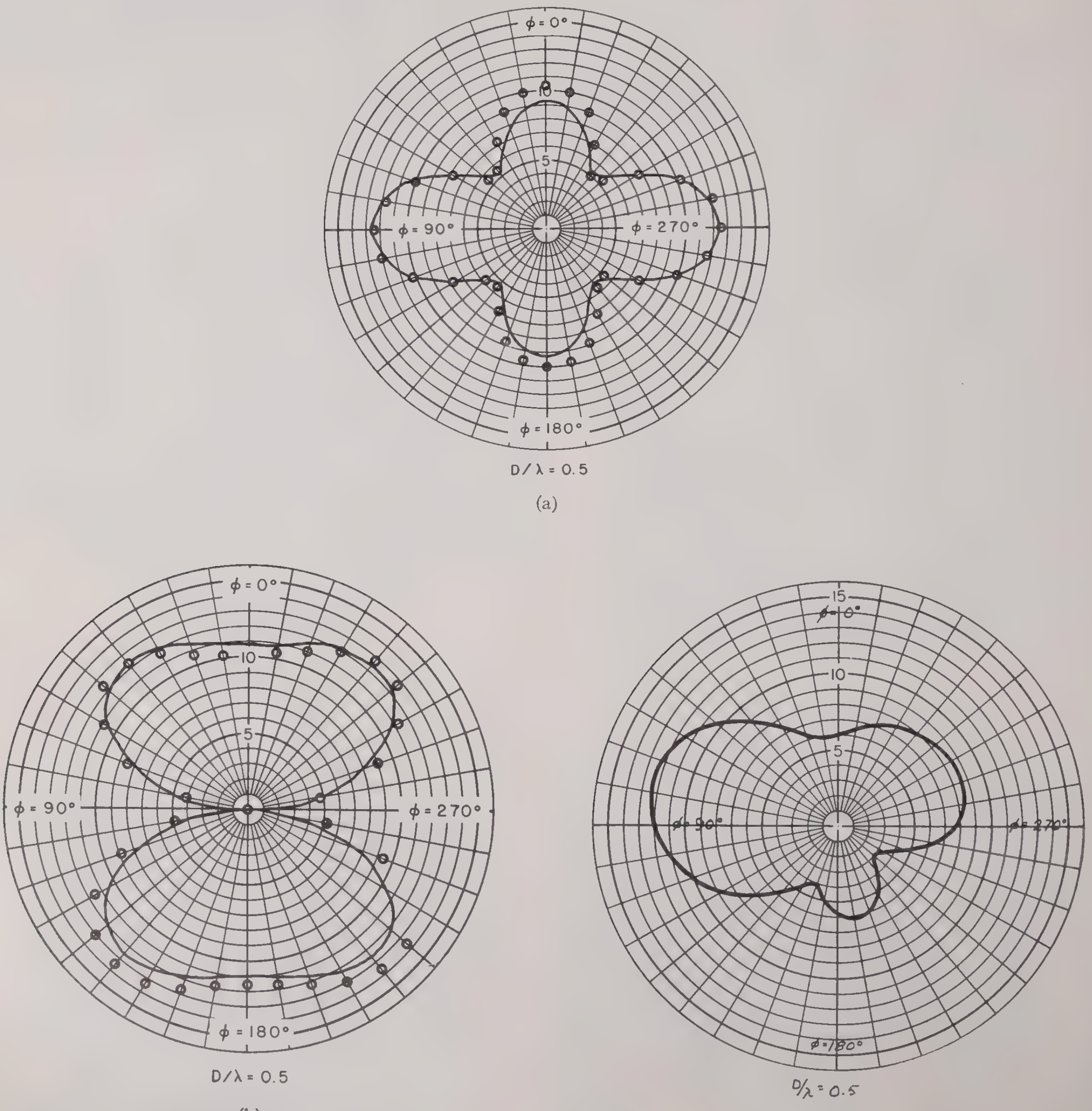
ADJUSTMENT OF SLOTTED-CYLINDER ARRAYS

It is necessary to use a trial-and-error method in adjusting antenna arrays of this type to produce a given calculated pattern. In certain special cases it is easy to design a feed system to produce the calculated pattern, as, for example, when the slots are fed in phase with equal amounts of power.[4] Measurements have been made to prove it is possible to obtain the calculated patterns with properly designed feed systems, as shown in Figs. 9(a) and (b).

There seems to be very little information available on the impedance properties of slotted-cylinder antennas. Jordan and Miller have published some data on the impedances of single slots.[3] When two or more slots are used, there will be mutual impedances between the slots. No data on mutual impedances between slots on cylinders has appeared in the literature as yet.

Conclusions

It is apparent that considerable control over the patterns of slotted-cylinder antennas can be obtained by using arrays of slots. By using the expression in (2) for the field radiated from a single slot, it is possible to calculate, with adequate accuracy, the horizontal patterns of such arrays.



(a)

(b)

(c)

Fig. 9—Patterns of two slots in a cylinder one-half wavelength in diameter.
(a) Diametrically opposed slots fed equally and in phase.
(b) Diametrically opposed slots fed equally and out of phase.
(c) Slots at $\phi_1=0°$ and $\phi_2=90°$ with $M=0.5$ and $\psi=90°$.
The measured points shown in (a) and (b) were obtained at 1500 Mc.

A Swept-Frequency 3-Centimeter Impedance Indicator*

HENRY J. RIBLET†, ASSOCIATE, IRE

Summary—An item of test equipment is described which is capable of presenting on a cathode-ray tube sufficient information to determine the magnitude and phase of the impedance of a load at a number of closely spaced frequencies over a 12 per cent frequency range centered in the 3-cm band. The first model of the equipment measures reflection coefficients with an accuracy, for low standing-wave ratios, of ±4° in phase and ±8 per cent in magnitude. A novel rf circuit, called a wave sampler, makes the accuracy of this system independent of frequency.

I. Introduction

THE MEASUREMENT of impedance over a broad band of frequencies is one of the most tedious and time-consuming chores in the design and testing of radio-frequency components. Time is not the only loss, however, in using conventional standing-wave equipment. Inability to obtain quickly a picture of the over-all effect of small dimensional changes in the sample under test limits the performance obtainable from certain critical components. It is the object of this paper to describe a system which will present rapidly on a cathode-ray tube information from which may be readily deduced the magnitude and phase of a load at a number of closely spaced points in the 3-cm band.

Two essentially distinct systems for obtaining somewhat similar results have been discussed previously. Gaffney[1] has described a reflectometer which uses a "magic-tee" hybrid junction[2] to separate the power incident on a load from the power reflected by it. One may then compare these powers and determine the standing-wave ratio. For a complete discussion of the limitations of this system, the reader is referred to the original paper. In brief they are:

1. No measurement of phase is convenient. This restricts the usefulness of this piece of test equipment severely, since, for most experimental work, phase information is fully as important as amplitude information.

2. The accuracy, for standing-wave ratios near unity, is limited (for varying frequencies) by the performance of the hybrid circuit, since in this limit the measured reflected power depends on the phase of the power actually reflected in a manner not easily taken into account.

3. The need for comparing power levels differing by as much as 40 db in the case of well-matched components—actually the situation of principal interest for many applications—requires the additional complication of a more sensitive receiver than is ordinarily used in standing-wave measurements.

On the basis of these objections, work was begun early in 1946 on the arrangement to be described and has been continuing on a low-priority basis at the Submarine Signal Company ever since. We believe that it meets all of the objections listed above; however, it pays for this by giving correct impedance information only at a set of discrete frequencies. As a consequence, the present equipment appears to be useful only in measuring components known to have reasonable bandwidths.

The arrangement suggested by Samuel[3] and Korman[4] gives the magnitude and phase of a waveguide termination for a continuous range of frequencies. Its accuracy depends on a rather narrow-band waveguide circuit Calculations made on the basis of the analysis given by Samuel indicate serious errors for this waveguide circuit when it is used over a 12 per cent frequency band. Unfortunately, what amounts to crosstalk between the amplitude and the phase of the reflected wave would appear to make it rather difficult to remove these errors by calibration. Accordingly, it is felt that this system is a natural complement for the system here described.

II. The System

For an explanation of the operation of the swept-frequency impedance indicator, reference is made to the schematic diagram of Fig. 1. The rf energy, originating in a variable-frequency signal generator having reasonably constant output, is fed through a special waveguide circuit devised for this purpose and called a wave sampler, for want of a better name, and then through a known length of transmission line to the load whose impedance is to be measured. The wave sampler is a four-terminal-pair waveguide circuit. At two of its arms appear rf signals proportional to $A^2+B^2+2AB\cos\phi$ and $A^2+B^2-2AB\cos\phi$, regardless of frequency. Here A is the incident voltage in the main guide, B is the reflected voltage, and ϕ is their relative phase. It will be seen that the wave sampler, to be described in detail later on, is

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† Submarine Signal Company, Boston, Mass.

[1] F. J. Gaffney, "Microwave measurements and test equipments," Proc. I.R.E., vol. 34, pp. 778–780; October, 1946.

[2] W. A. Tyrrell, "Hybrid circuits for microwaves," Proc. I.R.E., vol. 35, pp. 1294–1307; November, 1947.

[3] A. L. Samuel, "An oscillographic method of presenting impedances on the reflection-coefficient plane," Proc. I.R.E., vol. 35, pp. 1279–1283; November, 1947.

[4] N. A. Korman, "Theory and design of several types of wave selectors," *Proc. Nat. Electronics Conference*, vol. 2, pp. 418–422; 1946.

equivalent to a section of waveguide having on it two identical, uncoupled, short probes one-quarter wavelength apart at all frequencies. Two voltages proportional to $A^2+B^2+2AB\cos\phi$ and $A^2+B^2-2AB\cos\phi$ are developed in suitable identical detectors and fed after amplification to a continuous computer which has an output proportional to the ratio of these voltages.

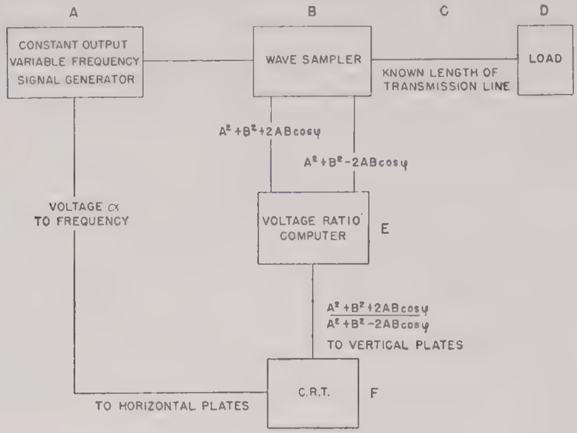

Fig. 1—Schematic of system.

This output voltage is applied to the vertical plates of a crt while the voltage on the horizontal plates is synchronized with the frequency of the signal generator, so that on the oscilloscope face we have a graph of $R=(A^2+B^2+2AB\cos\phi)/(A^2+B^2-2AB\cos\phi)$ against frequency.

It is fundamental to an understanding of the operation of this device to appreciate that ϕ, the phase of the reflected voltage B relative to the incident voltage A (measured at the wave sampler) is a function of the frequency, the length of line separating the load from the slots of the wave sampler, and the phase of the impedance of the load. At 3 cm, for a transmission line (C) whose length approximates 3 feet, ϕ changes sufficiently rapidly with λ, for reasonably broad-band loads, so that R takes on alternately the values $(A+B)^2/(A-B^2)$ and $(A-B)^2/(A+B)^2$ about once for every 1 per cent change in wavelength. These, of course, are true values of the square of the standing-wave ratio and its reciprocal, respectively. All other values of R lie between these extremes. Thus, on the face of the crt we see traces as shown in Figs. 6 and 7. True values of standing-wave ratio are given only at those wavelengths $\lambda_1, \lambda_2 \cdots \lambda_n$ which correspond to maxima and minima of the trace. Since the phase of the reflected wave at the wave sampler, $\lambda_1, \lambda_2, \cdots, \lambda_n$ and the length of the transmission are known, we are in a position to determine the phase as well as the magnitude of the impedance of the load at these wavelengths.

It is clear that the principles by which the impedance of a termination is determined with this arrangement are identical to those employed in slotted-line measurements. The use of the wave sampler and rather wide frequency variations combine to make *any mechanical motion unnecessary*. As a consequence, the speed with which the data may be presented on a crt is limited only by the time constants of the electronic circuits and the characteristics of the frequency-modulated signal generator. It seems reasonable to believe that, with a suitable signal generator, it should be possible with this arrangement to present the data containing the impedance of the load on a crt at a speed sufficient to give a continuous trace, as is now done at this frequency with conventional spectrum analyzers. Lacking such a signal generator, we have employed a tunable magnetron and have had no difficulty in covering a 6 per cent frequency band in 3.5 seconds.

SYSTEM COMPONENTS

Fig. 2 is a photograph of the waveguide and mechanical components used. A 2J51 tunable magnetron pulsed at a repetition rate of 1000 cps is used as the variable-frequency signal source. A very suitable reversing mechanism for tuning the magnetron back and forth across a 6 per cent frequency band was available out of war surplus, at a nominal cost, in the form of an aircraft control cable motor and clutch system. The magnetron, blower, reversing mechanism, and the potentiometer pick-off for moving the crt spot horizontally are shown at the left-hand side of Fig. 2. To avoid interaction between the load under test and the magnetron, about 30 db of padding is provided between them by a cross-type directional coupler.[5] The physical appearance of the wave sampler is clear from the photograph. At the output arms of the wave sampler may be seen the two Sperry barretters which detect the rf signals. The electronic circuits are not shown. Two chassis contain the power supplies, crt, and associated amplifiers. Another chassis contains the computer. It is a two-channel amplifier arranged so that a simultaneous automatic gain control holds the output of one of the channels constant. In this way, the output of the other channel gives the ratio of the input signals. To minimize the effects of tube unbalances, the same tubes are used in both channels. The numerator channel operates at 1 kc and the denominator at 3 kc. These frequencies are obtained directly from

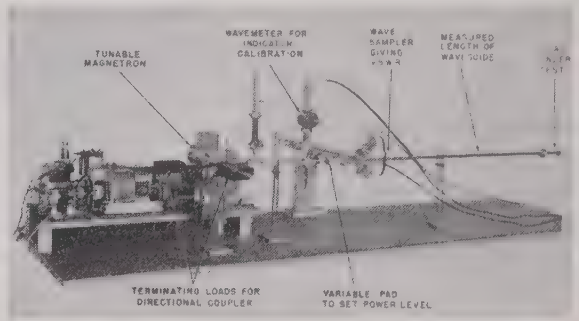
TUNABLE MAGNETRON
WAVEMETER FOR INDICATION CALIBRATION
WAVE SAMPLER GIVING VSWR
MEASURED LENGTH OF WAVEGUIDE
TERMINATING LOADS FOR DIRECTIONAL COUPLER
VARIABLE PAD TO SET POWER LEVEL

Fig. 2—Rf components.

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[5] M. J. Surdin, "Directive couplers in wave guides," *Jour. I.E.E.* (London), Pt. IIIA, vol. 93, p. 728; March-May, 1946.

the repetition rate of the magnetron by filtering in two sharply tuned amplifiers.

The wave sampler, which is fundamental to the accuracy and bandwidth of this scheme, is a special waveguide circuit designed specifically for this project. Although it is the outgrowth of considerable general discussion, its present form was suggested by Saad. The possibility that its rather surprising performance might be traced to basic symmetry considerations[6] was suggested by Lippmann and then worked out in detail by the writer. These arguments are presented in detail in the Appendix. Fig. 3 shows a cutaway view of the wave sampler. Terminals (1) and (2), as shown, are respectively connected to the signal generator and load. When terminals (4) and (6) are well matched, signals proportional to $A^2+B^2-2AB\cos\phi$ and $A^2+B^2+2AB\cos\phi$ are obtained from terminals (3) and (5). This is accomplished by cutting slots (a) and (b) in the main guide so that their centers fall in a plane perpendicular to the axis of this guide. Since slot (*b*) is excited by the total longitudinal current flow in the main guide, while slot (*a*) is excited by the total transverse current flowing in the main guide, it is easily argued that the excitation of slot (*b*) is proportional to the vector difference of the incident and reflected voltages, while the excitation of slot (*a*) is proportional to their vector sum (i.e., the equivalent probes are one-quarter wavelength apart at all frequencies). Fairly careful analysis, however, is required to show that the factors of proportionality are identical at all frequencies. As will be pointed out in the next section, this theoretical fact has been checked experimentally to within ±0.1 db over the 12 per cent 3-cm band.

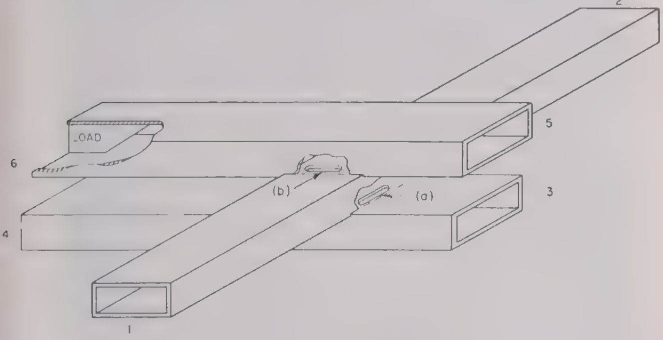

Fig. 3—Wave sampler.

PERFORMANCE

The most accurate way of using this equipment is to tune the magnetron manually across its band and record the maximum and minimum values of the output of the computer as indicated by a voltmeter, together with the frequencies at which they occur. Normalization of these values to the values obtained with a matched load at the same frequencies then allows one to determine the standing-wave ratio over the frequency band. The phase of the impedance of the load is determined from the length of the wave sampler and the frequencies at which the maximum and minimum values occur. Of course, the most rapid procedure consists in mechanically tuning the magnetron across the band and photographing the trace as it appears on the crt. The impedance data may then readily be obtained by comparison of the photograph obtained from the load under test with that obtained when the wave sampler is terminated with a matched load and with a short circuit.

Of these two methods, the first is the more accurate and gives the ultimate accuracy of the present apparatus, since it places no strain on the speed of the electronic circuits or on the linearity of the crt. Accordingly, three loads have been measured in this way, and the results compared with those obtained from slotted-line measurements. The results as concerns the absolute value of the standing-wave ratio are shown in Fig. 4. On the basis of these data, it is felt that the system will measure reflection coefficients of less than 0.20 (standing-wave ratios of magnitude less than 1.50) with an accuracy of better than ±8 per cent. An idea of the phase accuracy is obtainable from Fig. 5, which shows the impedance in both magnitude and phase at five selected points in the band for the three loads of Fig. 4. It is clear

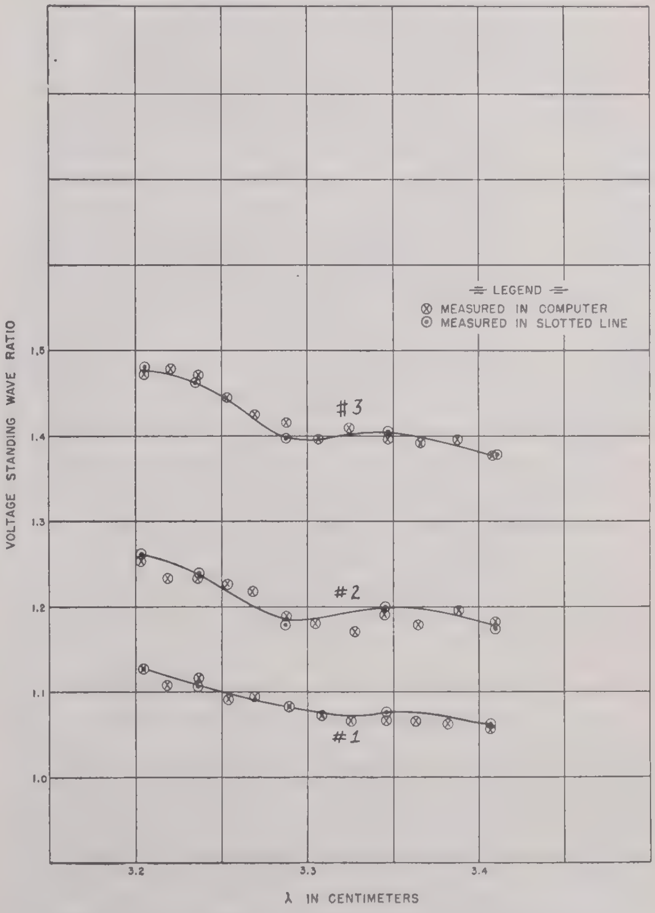

Fig. 4—Comparison of slotted-line and computer data.

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[6] The thinking that led Saad to this result was based on formulas due to H. Bethe (see footnote reference 5), and is thus rigorous only in the limit of small coupling slots.

that the phase accuracy is inversely related to the length of the wave sampler. It is our experience that the frequencies of the maximum and minimum values of the computer output can be determined to about ±1 part in 3000. If the length of the wave sampler centers around 20 guide wavelengths, as in this case, it is readily determined that the phase error will be in the neighborhood of ±0.01λ g. It will be observed that this is just about the accuracy obtained in Fig. 5. Absolute phase information would appear to depend on a precise knowledge of the frequency and the dimensions of the wave sampler. Actually, the wave sampler and wavemeter may be calibrated by shorting the output terminal of the wave sampler and determining the wavemeter readings at which the slots of the wavesampler are an integral number of quarter guide wavelengths from the short. By linearly interpolating between these readings, the absolute phase information plotted in Fig. 5 was obtained.

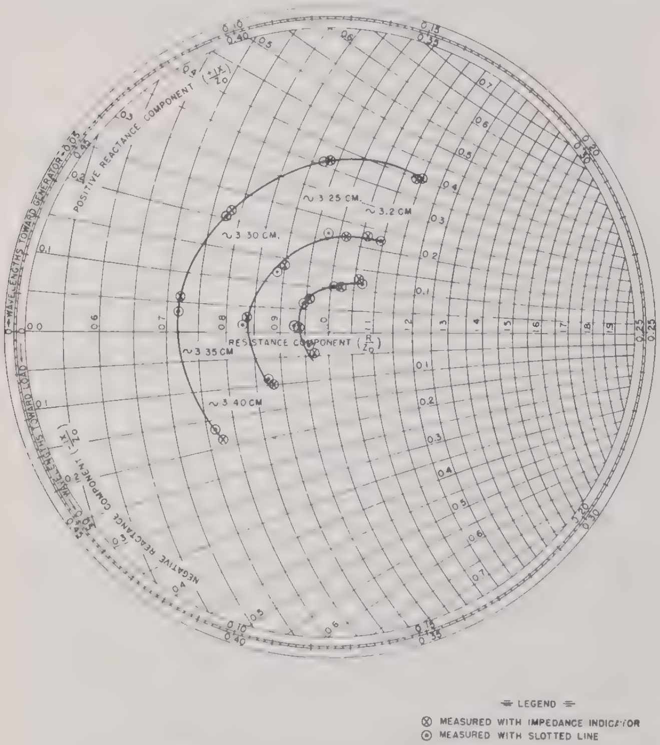

Fig. 5—Comparison of data on an impedance diagram.

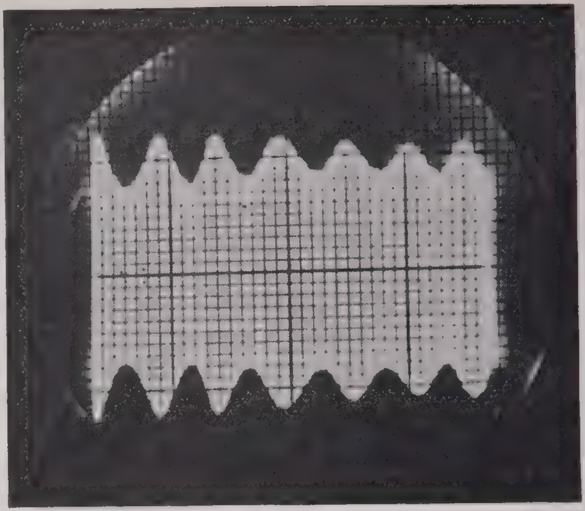

Fig. 6(a)—Trace of load No. 1.

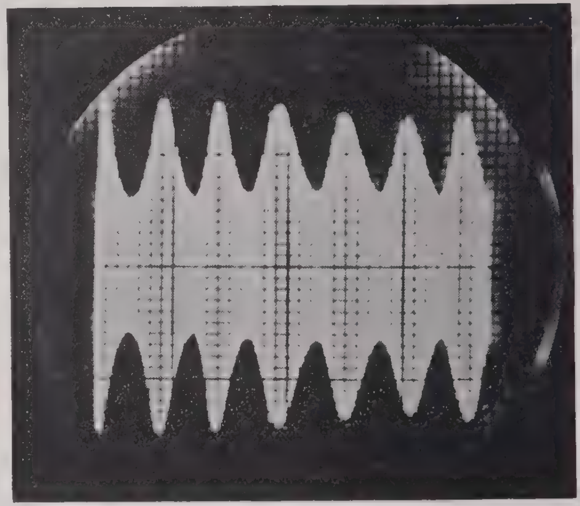

Fig. 6(b)—Trace of load No. 2.

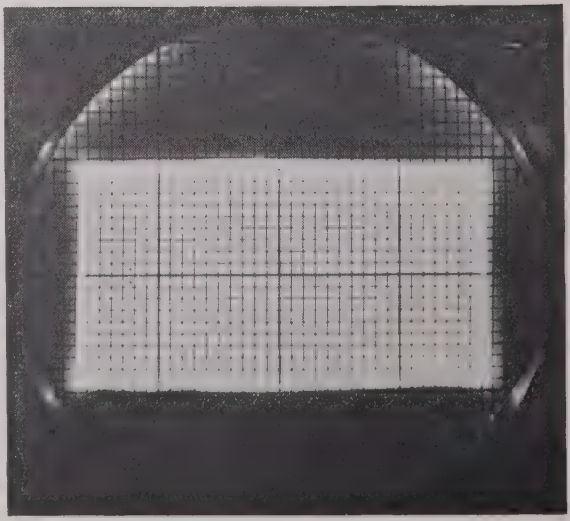

Fig. 6(c)—Trace of matched load.

Data obtained photographically are shown in Figs. 6(a), (b), (c) and 7(a), (b), (c). Figs. 6(a) and (b) show the traces for loads No. 1 and No. 2. These are to be compared with the trace obtained with a matched load in Fig. 6(c). Fig. 7(a) gives the data for load No. 3. Figs. 7(b) and (c) are the comparable data for a terminating short and matched load, respectively. Fig. 8 compares the values of the standing-wave ratio obtained from the photographs with those obtained from a slotted line. It should be recalled that the scope values were normalized to the values obtained from a matched load, so that the data are inherently more accurate for low standing-wave ratios. It is clear from Fig. 8 that, allowing for a certain amount of smoothing, which appears to be very permissible, the accuracy of the photographic procedure is more than adequate for most purposes. The phase characteristics of the load No. 3, say, may be readily determined by comparing Figs. 7(a) and (b). A lit-

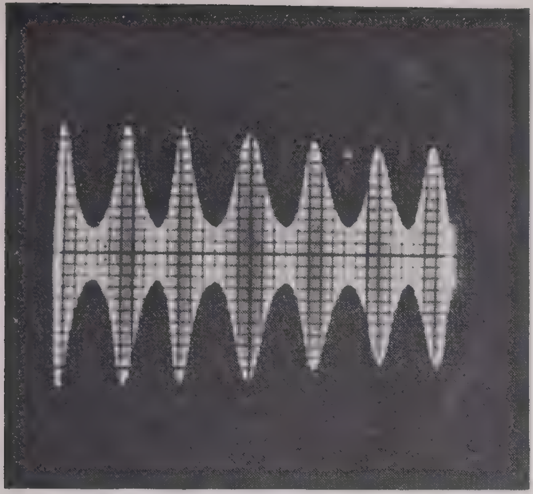

Fig. 7(a)—Trace of load No. 3.

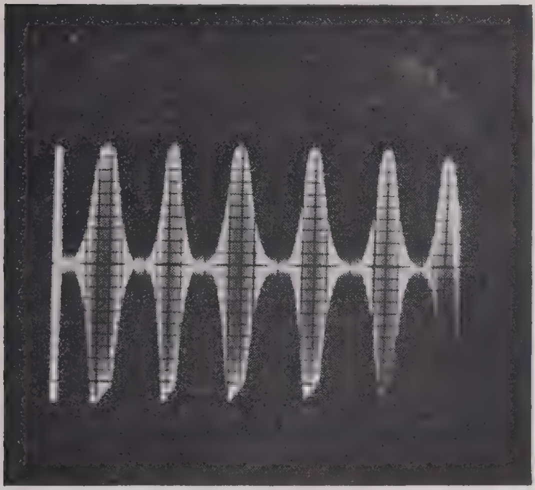

Fig. 7(b)—Trace of short circuit.

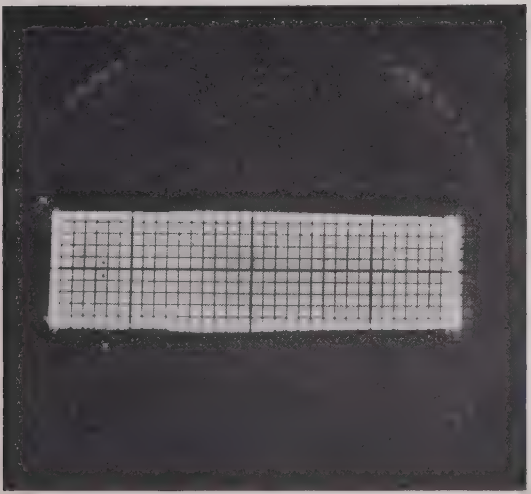

Fig. 7(c)—Trace of matched load.

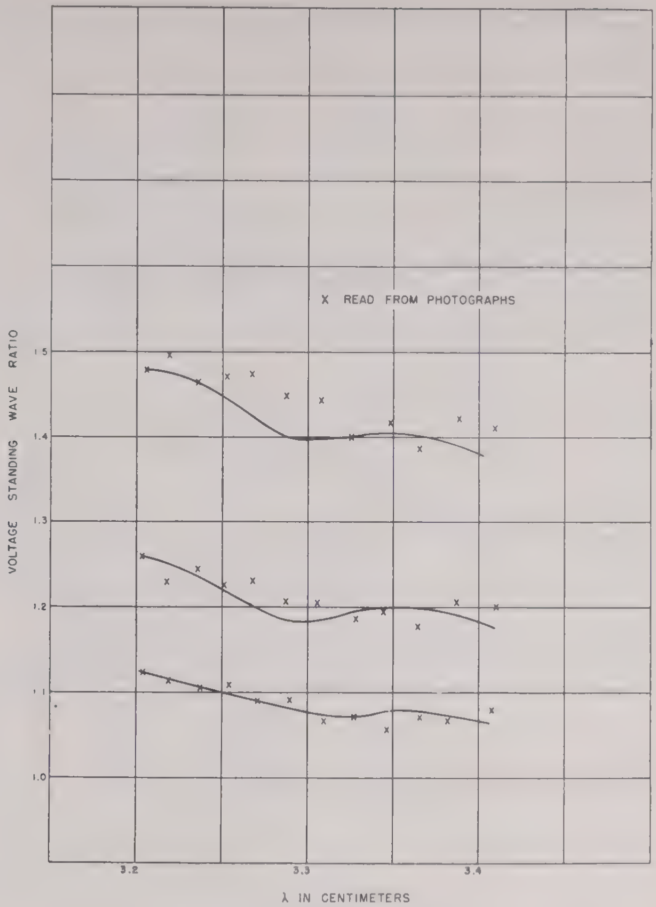

Fig. 8—Comparison of slotted line and photographed data.

tle consideration will show that the impedance of this load moves about half way around the circle diagram over the frequency band involved.

It will be observed that the data so far have been limited to a 6 per cent frequency band. The reason for this is simply that this band is adequate for the purposes for which the equipment was constructed, while a wider band was rather awkward to obtain with the mechanical reversing mechanism which was available. The only components of the system which in any way involve the frequency have, however, been tested over the 12 per cent band. The output of the tunable magnetron is, of course, constant over the band within 1 db. The items about which there remain some doubt are, then, the wave sampler and the barretters. The performance of these is shown in Fig. 9. The lower graph of this figure shows that the barretters are identical to within 0.1 db over the band. The signals out of the wave sampler, when terminated in a matched load, are the same within 0.2 db, as shown in the middle graph. The upper graph indicates that the combined unbalance of wave sampler and barretters taken together is less than 0.2 db over the 12 per cent band. Incidentally, the trace of Fig. 6(c) shows about this amount of variation for a matched load.

Acknowledgment

This development has required the co-operation of a number of persons, several of whom are no longer at the Submarine Signal Company. John Daspit designed and tested the ratio computer; Chester W. Young designed and tested the amplifier and indicator circuits; Charles Aker arranged the mechanical drive for the magnetron;

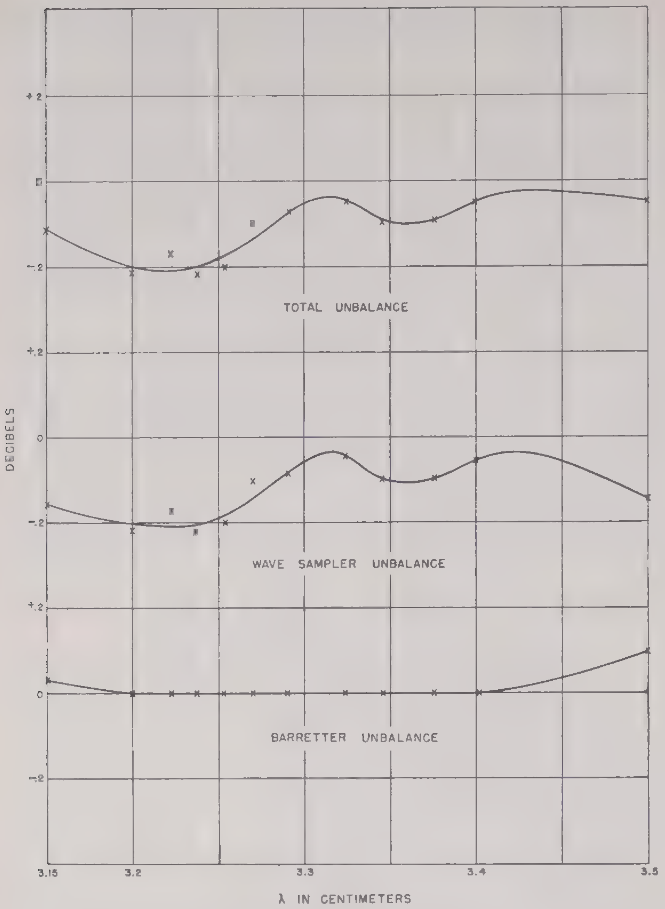

Fig. 9—Wave sampler unbalances.

and Miss Eileen Quigley has made the measurements reported in the paper. The contributions made by Saad and Lippmann have already been described.

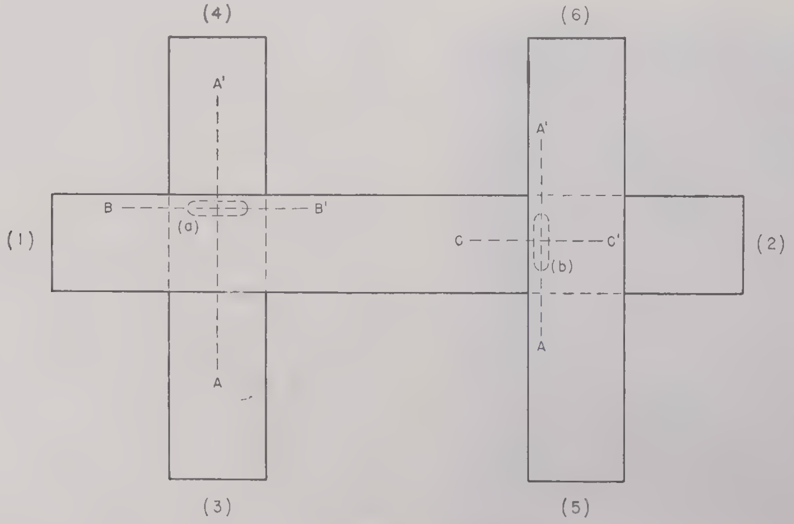

Fig. 10—Schematic of wave sampler.

APPENDIX

Fig. 10 gives a plan view of the wave sampler. For the sake of clarity, the wave guides 3–4 and 5–6 are shown displaced laterally from each other. The two lines AA' in the actual device are identical. Waveguide 5–6 is above waveguide 1–2, just as is shown in Fig. 5. Terminals (1) and (2), (3) and (4), and (5) and (6) are taken to be the same distance from the lines AA', BB', and CC', respectively.

On the assumption that the identical slots (*a*) and (*b*) are infinitesimally wide, the following statements follow from the mechanical and electrical symmetry of the device:

I. A field in slot (*a*) does not excite a field in slot (*b*), and vice versa.

II. Slot (*a*) is not excited by incident voltages antisymmetric about AA', and similarly for slot (*b*) as seen from guide 5–6.

III. Slot (*b*) is not excited by voltages symmetric about AA', and similarly for slot (*a*) as seen from 3–4.

IV. A field in slot (*a*) generates antisymmetric outgoing voltages in guide 3–4, and similarly for (*b*) in 1–2.

V. A field in slot (*b*) generates symmetric outgoing voltages in guide 5–6, and similarly for (*a*) in 1–2.

Consider in guide 1–2 the electromagnetic field which is established by two symmetric voltages of amplitude Φ_e incident on (1) and (2). Then, by III and IV, two outgoing fields antisymmetric about BB' will be generated in 3–4. The voltages at (3) and (4) will be denoted respectively by Ω_0 and $-\Omega_0$. We should now like to invoke the reciprocity theorem to show that antisymmetric voltages incident on 3–4 of magnitude Φ_e and $-\Phi_e$ respectively, will generate symmetric outgoing voltages at (1) and (2) of magnitude Ω_0. Since, by I and III, slot (*b*) is not excited by the assumed field configuration, there is no current flow across it, and we may assume that it is shorted out or closed over without altering the field in any of the guides. During this part of the argument, slot (*b*) need not exist, so we can consider the network whose terminals are (1), (2), (3), and (4). We write the equations relating reflected to incident voltages:

$$\begin{aligned} B_1 &= S_{11}A_1 + S_{12}A_2 + S_{13}A_3 + S_{14}A_4 \\ B_2 &= S_{12}A_1 + S_{22}A_2 + S_{23}A_3 + S_{24}A_4 \\ B_3 &= S_{13}A_1 + S_{23}A_2 + S_{33}A_3 + S_{34}A_4 \\ B_4 &= S_{14}A_1 + S_{24}A_2 + S_{34}A_3 + S_{44}A_4 \end{aligned} \tag{1}$$

where B_i and A_i are the reflected and incident voltages at the i^{th} terminal. The matrix (Sij) of this system of equations is known as the scattering matrix of the network and may easily be shown to be symmetric, a fact already assumed in (1). Since the network is symmetric with respect to an interchange of terminals (1) and (2), $S_{11}=S_{22}$, $S_{13}=S_{23}$, and $S_{14}=S_{24}$. Moreover, it is clear that $S_{33}=S_{44}$ and, by IV, $S_{13}=-S_{14}$ and $S_{23}=-S_{24}$. Thus (1) becomes

$$\begin{aligned} B_1 &= S_{11}A_1 + S_{12}A_2 + S_{13}A_3 - S_{13}A_4 \\ B_2 &= S_{12}A_1 + S_{11}A_2 + S_{13}A_3 - S_{13}A_4 \\ B_3 &= S_{13}A_1 + S_{13}A_2 + S_{33}A_3 + S_{34}A_4 \\ B_4 &= -S_{13}A_1 - S_{13}A_2 + S_{34}A_3 + S_{33}A_4. \end{aligned} \tag{2}$$

In the absence of energy incident on terminals (3) and (4), incident voltages Φ_e at (1) and (2) generate outgoing waves at (3) and (4) which are $2\,S_{13}\,\Phi_e$ and $-2\,S_{13}\,\Phi_e$, respectively. Thus $\Omega_0 = 2\,S_{13}\,\Phi_e$.

We then see from (2) that voltages Φ_e and $-\Phi_e$ incident on (3) and (4) respectively, in the absence of energy incident on (1) and (2), generate outgoing voltages at (1) and (2) which are both Ω_0. This is what we wished to prove.

Now the geometry seen by incident antisymmetric voltages at (3) and (4) is identical to that seen by antisymmetric voltages at (1) and (2), since slot (*a*) may be assumed to be closed for this case. Thus, if symmetric incident voltages at (1) and (2) of magnitude Φ_e establish voltages Ω_0 and $-\Omega_0$ at (3) and (4), antisymmetric voltages Φ_e and $-\Phi_e$ incident at (1) and (2) will establish symmetric voltages of magnitude Ω_0 at (5) and (6). The sum of two solutions of Maxwell's equations is again a solution and we conclude that, if the only voltage incident on the network is $2\,\Phi_e$ at terminal (1), the outgoing voltages at (3), (4), (5), and (6) will be Ω_0, $-\Omega_0$, Ω_0, and Ω_0, respectively. Thus the device has the property, under the condition of perfect match at terminal (2), that for power incident at (1), equal powers appear at the other terminals. Clearly, then, if terminals (4) and (6) are perfectly terminated, terminals (3) and (5) are equivalent to identical uncoupled probes at all frequencies. That they are one-quarter wavelength apart, as has already been indicated, follows from the fact that slot (*a*) is in parallel with guide 1–2, while slot (*b*) is in series with it.

Of course, the slots, unless small themselves, will interact with the quantities to be measured and give rise to appreciable errors. We may evaluate this type of error as follows. The scattering matrix for the complete six-terminal network is, on the basis of remarks of the previous paragraph,

$$\begin{array}{llllll} B_1= & S_{11}A_1+S_{12}A_2+S_{13}A_3-S_{13}A_4+S_{13}A_5+S_{13}A_6 \\ B_2= & S_{12}A_1+S_{11}A_2+S_{13}A_3-S_{13}A_4-S_{13}A_5-S_{13}A_6 \\ B_3= & S_{13}A_1+S_{13}A_2+S_{33}A_3+S_{34}A_4 \quad 0 \quad 0 \\ B_4= & -S_{13}A_1-S_{13}A_2+S_{34}A_3+S_{33}A_4 \quad 0 \quad 0 \\ B_5= & S_{13}A_1-S_{13}A_2 \quad 0 \quad 0 \quad S_{55}A_5+S_{56}A_6 \\ B_6= & S_{13}A_1-S_{13}A_2 \quad 0 \quad 0 \quad S_{56}A_5+S_{55}A_6. \end{array} \tag{3}$$

For voltages A_1 and A_2 incident on terminals (1) and (2), $B_3=S_{13}\,(A_1+A_3)$ and $B_5=S_{13}\,(A_1-A_2)$. Thus the ratio of the power out of terminals (3) and (5) is

$$\frac{|A_1+A_2|^2}{|A_1-A_2|^2} = \frac{\left|1+\dfrac{A^2}{A_1}\right|^2}{\left|1-\dfrac{A^2}{A_1}\right|^2} \tag{4}$$

independently of frequency. If the voltage incident on the wave sampler A_1 were the same as the voltage B_2 incident on load under test, this device would be exact, regardless of the size of the coupling slots. Of course, this is not the case. Actually, by (3), $B_2=S_{12}A_1+S_{11}A_2$. Thus the ratio of the power at terminals (5) and (3) equals

$$\frac{|B_2+(S_{12}-S_{11})A_2|^2}{|B_2-(S_{12}+S_{11})A_2|^2}. \tag{5}$$

In the limit of small slots $S_{13}\rightarrow S_{11}\rightarrow 0$ and $|S_{12}|\rightarrow 1$, so that (5) approaches

$$\frac{A^2+B^2+2AB\cos\phi}{A^2+B^2-2AB\cos\phi}.$$

For the wave sampler pictured in Fig. 2, $|S_{13}|=0.01$ and $|S_{11}|$ was approximately 0.005. Since the matrix of (3) is known to be unitary, we have that

$$|S_{11}|^2+|S_{12}|^2+4|S_{13}|^2=1. \tag{6}$$

Then $|S_{12}|^2=1-4.10^{-4}-0.25\times10^{-4}\approx 0.9995$. For small standing-wave ratios, then, this gives an error in the reflection coefficient of, at most, about one-half of one per cent. This is a truly insignificant error in the standing-wave ratio.

It might be interesting to point out that by making guides 3–4 and 5–6 coincide, and by superimposing slots (*a*) and (*b*) in the form of a cross, one is led to a type of directional coupler whose directivity is, in theory at least, independent of the frequency. The proof given here, however, is more general than that given by Surdin,[7] since no restrictions need be placed on the size of the slots other than those required for the validity of I–V. Furthermore, it is rather easy to imagine analogous coaxial-line circuits by making use of the notion of series and parallel coupling essential to the symmetry of the wave sampler.

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[7] See footnote reference 5. Surdin's discussion of the properties of the cross-type directional coupler depends on formulas due to Bethe, which may readily be shown to be incorrect for slots of finite size.

The Ultrasonic Interferometer with Resonant Liquid Column*

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Summary—**The ultrasonic interferometer is simple in construction and operation, and yields accurate and consistent data. From these data, one can readily determine the velocity of sound in a liquid with high accuracy. Formerly, the absorption of sound in the liquid and the coefficient of reflection at the reflector surface has been obtained through a complicated analysis of the electrical and equivalent-electrical circuits of the quartz crystal and the associated fluid column. The simplified analysis of the equivalent circuit given here is made possible by limiting the discussion to the conditions that exist when all parts of the system (electrical, mechanical, and acoustical) are adjusted to resonance. Under these conditions, the analysis of the complete electrical and equivalent-electrical circuit is greatly simplified. One does not need to analyze the shape of a reaction dip in order to obtain coefficients of absorption and reflection.**

VARIOUS AUTHORS, such as Cady,[1] Van Dyke,[2] and Dye,[3] have developed the analysis of the equivalent electrical circuit of the quartz-crystal resonator. Hubbard[4] has extended the analysis to include the modification introduced by a fluid column coupled to the resonator. He assumed the sound source to be an infinite plane executing simple harmonic motion. The plane progressive waves thus generated in the fluid are reflected from an infinite plane surface at a distance r from the source. Hubbard expressed the particle velocity (pressure) and displacement at each point in the fluid and calculated the effect of the multiply reflected waves on the sound source. These assumptions are valid if one uses a source with a diameter large compared to the wavelength of the sound in the fluid.

Hubbard measured the current variation produced as the reflector-to-source distance r is varied and from these changes calculated the coefficient of absorption in several gases and the coefficient of reflection at the reflector surface. Fox[5] adapted Hubbard's theory to the corresponding measurements for liquids and determined the absorption coefficient for water. Using the interferometer, Hunter[6] measured the absorption coefficients for several highly viscous liquids. Previous to these interferometric measurements the values obtained by other methods had varied over several orders of magnitude. Recent results using other methods (e.g., sound pulse) have converged to the values first measured with the ultrasonic interferometer.

Hubbard's treatment of the interferometer necessitates extensive analytical and graphical analysis in order to obtain coefficients of absorption and reflection from experimental data. It is the purpose of this paper to propose a simplified theory for the ultrasonic interferometer at resonance, i.e., electrical resonance for the LC circuit, mechanical resonance for the crystal, and acoustical resonance for the fluid column.

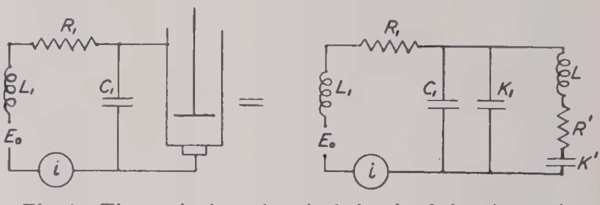

Fig. 1—The equivalent electrical circuit of the ultrasonic interferometer and associated electrical pickup circuit.

Hubbard's theory gives a general analysis of the current in a pickup circuit which has an ultrasonic interferometer connected across a tuning capacitor as shown as shown in Fig. 1. We give his results, using the following notation. L_1, C_1, and R_1 are the purely electrical inductance, capacitance, and resistance of the pickup circuit. L, K, and R are the corresponding equivalent electrical constants of the quartz resonator vibrating in a vacuum close to its natural mechanical resonance frequency, and K_1 is its clamped[7] dielectric capacitance. A voltage $E_0\, e^{j\omega t}$ is induced in L_1 by a loosely coupled oscillator. When a fluid column is in contact with the resonator, the equivalent resistance and capacitance of the resonator is changed, and these modified values R' and K' are defined by

$$R' = R + AB\rho vP \tag{1}$$

$$1/K' = 1/K + AB\rho v\omega Q \tag{2}$$

where A is the effective area of the resonator face exposed to the fluid column, B is a piezoelectric constant of the quartz, ρ is the density, and v is the velocity of sound in the liquid, P and Q are expressions[8] determining the

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[4] J. C. Hubbard, "Acoustic resonator interferometer: I. The acoustic system and its equivalent electric network," *Phys. Rev.*, vol. 38, pp. 1011–1019; September, 1931; also, "Acoustic resonator interferometer: II. Ultrasonic velocity and absorption in gases," vol. 41, pp. 523–535; August, 1932; and errata, "Acoustic resonator interferometer," vol. 46, p. 525; September, 1944.

[5] F. E. Fox, "Ultrasonic interferometry for liquid media," *Phys. Rev.*, vol. 52, pp. 973–981; November, 1937.

[6] J. L. Hunter, "The absorption of ultrasonic waves in highly viscous liquids," *Jour. Acous. Soc. Amer.*, vol. 13, pp. 36–40; July, 1941.

[7] K_1 is the dielectric capacitance at constant strain; or the capacitance the resonator would have if, other things being the same, the quartz were not piezoelectric. See P. Vigoreux, "Quartz Oscillators," p. 11, London, 1939; W. G. Cady, "Piezoelectricity," p. 311, McGraw-Hill Book Co., New York, N. Y., 1946.

[8] In the Hubbard paper, P and Q are written for any position x between the source and the reflector. Only the values at the source interest us here, and these are obtained by placing $x=0$ in Hubbard's general equations.

acoustic resistance and reactance of the fluid column at the resonator surface. The current in the L_1C_1 branch is i, and I_0 is used to denote (E_0/R_1), the resonance current in the L_1C_1 branch when the interferometer is disconnected and C_1 readjusted to resonance. The current ratio (i/I_0) is designated by σ. Then

$$\sigma^2 = \frac{\phi_1^2\left[\phi_2^2 + \left(q + \dfrac{K'}{C_1+K_1}\right)^2\right]}{\left[pq - \phi_1\phi_2 - (1-p)\dfrac{K'}{C_1+K_1}\right]^2 + \left[\phi_2 p + \phi_1\left(q + \dfrac{K'}{C_1+K_1}\right)\right]^2} \tag{3}$$

where

$$p = 1 - (C_1 + K_1)L_1\omega^2$$

$$q = 1 - LK'\omega^2; \quad q_0 = 1 - LK\omega^2$$

$$\phi_1 = R_1(C_1 + K_1)\omega$$

$$\phi_2 = R'K'\omega.$$

In interferometry the usual practice is to make certain experimental adjustments that permit one to use a simplified form of (3). Thus, if the frequency of the oscillator is adjusted, as described by Hubbard, to the response frequency of the quartz before it is modified by the loading of the liquid column, $[q_0+K'/(C_1+K_1)]$ is zero; if the L_1C_1 circuit is adjusted to resonance[9] at this same frequency, p is zero, and we have

$$\sigma^2 = \frac{(1+SP)^2 + S^2Q^2}{(1+SP+C)^2 + S^2Q^2} \tag{4}$$

where[10] $S = AB\rho v/R$, and C is written for $[R\omega\phi_1(C_1+K_1)]^{-1}$, an expression containing only electrical and equivalent electrical constants unmodified by the fluid column. This is the fundamental equation of ultrasonic interferometry. It has been discussed at length by Hubbard and Fox. In it P and Q are functions of the reflector positions. It is the variations of P and Q that produce the characteristic dips at odd quarter-wavelength settings of the reflector when liquids are used, or peaks at half-wavelength settings in gases. In order to obtain the coefficients of absorption and reflection, one must determine the shape of a dip when the reflector is near the source, the successive dip minima, and the value of C. The calculations are involved, and graphical interpolation is used in the evaluation. A more serious difficulty comes from the fact that with many resonators the shape of the dip is distorted by the presence of "satellite" dips. Even if these are too small to appear separately, they may nevertheless distort the shape of the dip.

It will be shown here that it is possible to avoid these difficulties and obtain the acoustic coefficient quite simply when the absorption is large, and this can always be realized by working at sufficiently high frequencies. The method may be outlined as follows. At a dip minimum the liquid column is at resonance, and the equation for σ at these positions assumes a very simple form. From a set of these σ at dip minima together with values of σ found when the reflector is far enough away for the dips to disappear, and when the liquid is removed from the interferometer, one can plot a set of points that should lie on straight line with slope equal to the coefficient of absorption and a y intercept at $r=0$ from which the coefficient of reflection can be determined.

In (4), P and Q are defined:

$$P = \frac{1 - \gamma^2 e^{-4r\alpha}}{1 + \gamma^2 e^{-4r\alpha} - 2\gamma e^{-2r\alpha}\cos\left(\dfrac{2r\omega}{v}\right)} \tag{5}$$

$$Q = \frac{2\gamma e^{-2r\alpha}\sin\left(\dfrac{2r\omega}{v}\right)}{1 + \gamma^2 e^{-4r\alpha} - 2\gamma e^{-2r\alpha}\cos\left(\dfrac{2r\omega}{v}\right)} \tag{6}$$

where $\omega = 2\pi$ times the frequency of the driving voltage; α is the amplitude coefficient of absorption of the sound in the liquid; and γ is the amplitude coefficient of reflection.[11] We write

$$\gamma = e^{-\beta}$$

$$2r\alpha + \beta = X$$

$$\frac{2r\omega}{v} = \frac{4\pi r}{\lambda} = \delta$$

and then[12] have

$$P = \frac{\sinh X}{\cosh X - \cos\delta} \tag{7}$$

$$Q = \frac{\sin\delta}{\cosh X - \cos\delta}. \tag{8}$$

For $r = \infty$, $X = \infty$ and

$$P = 1 \tag{9}$$

$$Q = 0. \tag{10}$$

Whenever $r = m\lambda/4$ where m is an integer, Q is zero and the liquid column is at resonance, having no acoustic reactance. These are the critical points in acoustic interferometry, and the variations of σ with r near these points[13] depends on the SP term in (4). Where m is even, P is a maximum; where m is odd, P is a minimum. Since S is large compared to C for liquids, σ remains near unity except where P is a minimum as Q goes through zero. This occurs at the positions of the reflector where $r=(2n-1)\lambda/4$ and is the reason for the "dip" in σ that is characteristic of acoustic interferometry with liquids. Here n is the dip number and the value of P at these points is P_0, so we have

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[9] These are the adjustments that insure a "symmetrical crevasse" when σ is plotted as a function of frequency.

[10] S is the ratio of the equivalent resistance of an infinitely long fluid column to the equivalent resistance R of the unloaded quartz resonator. For columns of finite length, SP is the ratio of the resistive (real) part of the equivalent impedance due to the column to the equivalent resistance R, and SQ is the ratio of the equivalent reactance of the finite column to the equivalent resistance R.

[11] The theoretical treatment of the coefficient of reflection has been developed by K. F. Herzfeld, "Reflection of sound," *Phys. Rev.*, vol. 53, pp. 899–906; June, 1938.

[12] The interpretation of the coefficients of reflection as measured in acoustic interferometry, following Herzfeld's theory, has been given by R. S. Alleman, "Dissipative acoustic reflection coefficients in gases by ultrasonic interferometry," *Phys. Rev.*, vol. 55, pp. 87–93; January, 1939.

$$\sigma_{\text{on}} = \frac{1 + SP_{\text{on}}}{1 + SP_{\text{on}} + C} \tag{11}$$

where

$$P_{\text{on}} = \frac{\sinh X_{\text{on}}}{\cosh X_{\text{on}} + 1} = \tanh\left(\frac{X_{\text{on}}}{2}\right). \tag{12}$$

At this point it is useful to rewrite (4) in the simplified form that applies when the interferometer is at resonance electrically, mechanically, and acoustically, as described above. From the definition of S, and (1), $SP=(R'-R)/R$, so we have at resonance

$$\sigma_{\text{on}} = \frac{1}{1 + \dfrac{R}{R_{\text{on}}'}C} = \frac{1}{1 + \dfrac{1}{R_{\text{on}}'R[\omega(C_1+K_1)]^2}}, \tag{13}$$

recalling that, since $p=0$, $[\omega(C_1+K_1)]^{-1}=\omega L_1$,

$$\sigma_{\text{on}} = \frac{1}{1 + \dfrac{\omega^2 L_1^2}{R_1 R_{\text{on}}'}} \tag{14}$$

or

$$i_{\text{on}} = \frac{E_0}{R_1 + \dfrac{\omega^2 L_1^2}{R_{\text{on}}'}} = \frac{E_0}{R_1 + \left(\dfrac{L_1}{C_1+K_1}\right)\dfrac{1}{R_{\text{on}}'}}. \tag{15}$$

Thus at resonance the total impedance of the combined interferometer and electrical pickup circuit can be simply expressed as the resistance Z in the equivalent forms

$$Z = R_1 + \left(\frac{L_1}{C_1+K_1}\right)\frac{1}{R_{\text{on}}'} = R_1 + \frac{\omega^2 L_1^2}{R_{\text{on}}'}. \tag{16}$$

where R_1, L_1, and (C_1+K_1) are purely electrical constants of the pickup circuit and the clamped dielectric capacitance of the quartz, and R_{on}' is the equivalent resistance of the resonator loaded by the resonant liquid column. This equation is valid only at dip minima. To indicate this we have used R_{on}' for the value of R' at the nth dip minimum, and i_{on} for the corresponding current.

Equations (13) and (14) show clearly and simply how the current in the pickup circuit increases as R' grows larger with longer liquid columns. They show, too, how the difference in i_{on} from dip to dip depends upon the square of the surge impedance $L_1/(C_1+K_1)$ or $\omega^2 L_1^2$ of the pickup circuit, and indicate the advantage of keeping ωL_1 large. Also, from (16) we see that the equivalent circuit of the interferometer with the associated pickup circuit and resonant liquid column, adjusted as described above, may be represented as shown in Fig. 2, where the notation is identical to that used in Fig. 1.

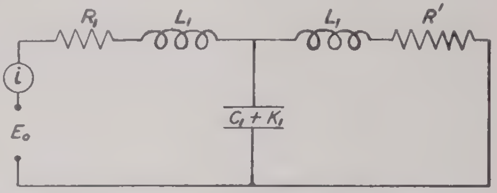

Fig. 2—The equivalent electrical circuit of the ultrasonic interferometer at resonance.

In Fig. 3 we have plotted σ_{on} as a continuous function of R_{on}', although of course (14) is valid only for discrete values of the independent variable R_{on}'. The minimum

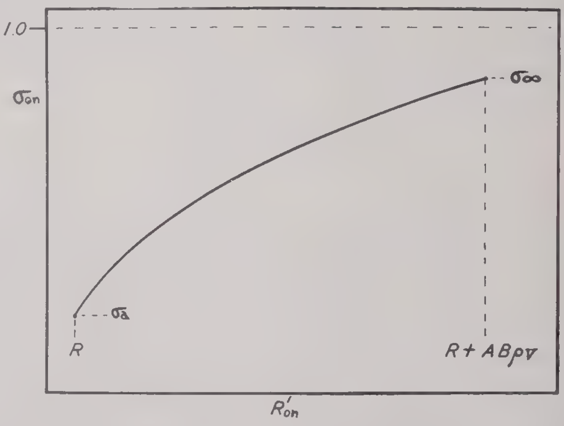

Fig. 3—σ_{on} as a function of R_{on}' as given by equation (14). The minimum value of R_{on}' is simply R, the equivalent resistance of the unloaded resonator. The maximum value of R_{on}' is R plus the equivalent resistance of an infinitely long liquid column.

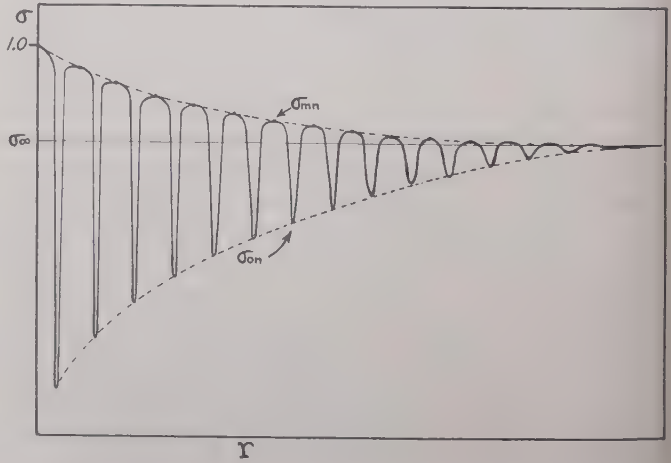

Fig. 4—σ as a function of the column length r as given by equation (4)

value of R_{on}', (1), is simply the equivalent resistance R of the unloaded resonator, and the maximum value is $R+AB\rho v$ where $AB\rho v$ is the equivalent resistance of an infinitely long column of liquid of cross-sectional area A and acoustic radiation resistance ρv.

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[13] See footnote reference 5 for detailed discussion of the behavior of σ in liquids and gases, and for graphs of P and Q as functions of r.

In Fig. 4 we have sketched σ as function of r as given by (4). The envelope of the dip minima is to be compared to the curve of Fig. 3.

We now discuss (9) to show how the coefficients of absorption and reflection may be evaluated. We first determine C, which is independent of the fluid column. This can be done by measuring σ with the liquid removed from the interferometer. Ideally, this measurement should be made with the quartz resonator vibrating in a vacuum, but this is unnecessary since S is so small in air compared with S in liquids (because of the difference in densities). However, one can make the SP term entirely negligible by setting the reflector in air so that P is a minimum, i.e., at $r=\lambda/4$ in air. Calling σ thus measured σ_a, we have

$$\sigma_a = \frac{1}{1+C} \tag{17}$$

or

$$C = \frac{1-\sigma_a}{\sigma_a}\cdot \tag{18}$$

The liquid is placed in the interferometer and S is determined in the following manner. At dip minima where $\delta=(2n-1)\pi$,

$$P_{on} = \tanh\left(\frac{X_{on}}{2}\right),$$

while for points midway between minima where $\delta=2n\pi$,

$$P_{mn} = [\tanh(X_{mn}/2)]^{-1}. \tag{19}$$

Obviously, for large values of X

$$P_m \to P_0 \to P_\infty = 1 \tag{20}$$

where P_∞ is the value of P for $r=\infty$.

By measuring σ at very large values of r, one can determine σ_∞. The experimental criterion of how large r must be is supplied by the disappearance of the dips (see Fig. 4) as the reflector is withdrawn from the crystal.[14] It is, however, unnecessary to measure σ_∞ directly, since one can easily and accurately determine it by plotting maximum and minimum values of σ and estimating the value σ_∞ that both approach asymptotically from opposite sides. From equation (11),

$$SP_{on} = \frac{\sigma_{on}(1+C)-1}{1-\sigma_{on}} \tag{21}$$

and

$$SP_\infty = S = \frac{\sigma_\infty(1+C)-1}{1-\sigma_\infty} = \frac{\sigma_\infty-\sigma_a}{\sigma_a(1-\sigma_\infty)}\cdot \tag{22}$$

Therefore S can be found from experimentally[15] determined σ values.

It is now simple to determine α and β. From the current at the nth dip minimum one finds σ_{on} and calculates P_{on} for r_n:

$$P_{on} = \frac{\sigma_{on}(1+C)-1}{S(1-\sigma_{on})} = \frac{\sigma_{on}-\sigma_a}{S\sigma_a(1-\sigma_{on})} = \frac{(\sigma_{on}-\sigma_a)(1-\sigma_\infty)}{(1-\sigma_{on})(\sigma_\infty-\sigma_a)}\cdot \tag{23}$$

From (10),

$$P_{on} = \tanh\left(\frac{X_{on}}{2}\right) = \tanh\left(\frac{2r_n\alpha+\beta}{2}\right) \tag{24}$$

$$2r_n\alpha+\beta = 2\tanh^{-1}(P_{on}). \tag{25}$$

Thus we plot (Fig. 5) 2 $\tanh^{-1}(P_{on})$ (ordinate) against r_n (abscissa) and obtain a straight line of slope 2α, and with a y intercept ($r=0$) equal to $\beta=-\ln\gamma$.

It should be emphasized that the simplified interferometric theory presented here is not an approximation of the exact general theory as developed by Hubbard and Fox, but is the exact theory of the current minima; that is, of the interferometer at resonance as defined above. In order to evaluate the acoustic coefficients one need only measure σ_a, σ_∞, and a series of σ_{on}. Formerly, one was obliged to determine the shape of a dip, and one of the great difficulties of ultrasonic interferometry was the necessity of obtaining quartz-crystal resonators for which the dips are entirely free of secondary or satellite responses.

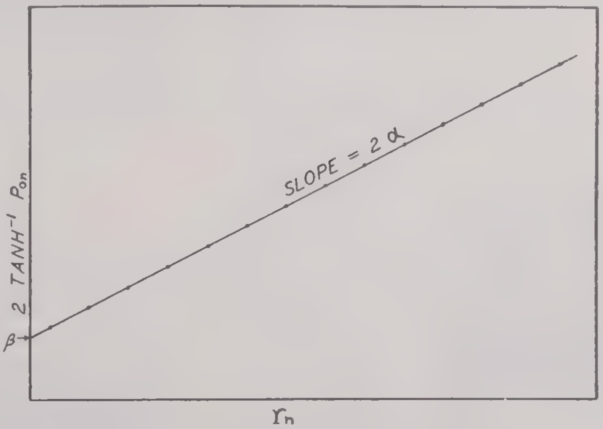

Fig. 5—2 $\tanh^{-1}(P_{on})$ as a function of the column length r. The value of P_{on} for any dip n is obtained from σ_a, σ_∞, and σ_{on}.

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[14] Whether one could determine σ_∞ by skewing the reflector so as to make the effective β and thus X large would have to be determined by measurements in a highly absorbing liquid. One would determine σ_∞ directly, then skew the reflector, and see how close to the source one could advance the reflector without changing σ_∞.

[15] It is possible, although slightly less simple, to eliminate S by measurements of the maximum values σ_{mn} using (17). In this case it is not necessary to determine σ_∞ (or, if one chooses, σ_a, instead of σ_∞). Hubbard, in an unpublished treatment, has pointed out how this can be done. In either case, the labor both of observation and calculation is greatly reduced. See E. E. Swomley, "Dispersion of the velocity and anomalous absorption of sound in hydrogen," p. 4, doctoral dissertation, Johns Hopkins University, 1946.

Contributors to Proceedings of the I.R.E.

John E. DeTurk

John E. Deturk was born in Urbana, Ill., on February 5, 1921. From 1938 to 1942 he attended the University of Illinois, where he pursued studies leading to the B.S. degree in physics. From 1943 to 1946 he was a member of the staff of the Harvard University Underwater Sound Laboratory, a war research organization sponsored by the Office of Scientific Research and Development.

Since 1946 Mr. DeTurk has been employed by the Raytheon Manufacturing Company, as a senior electronics engineer. In June, 1947, he became associated with the computer equipment section of the Raytheon Company, and has since been engaged in the design and development of automatic digital-computing equipment.

◆

Francis E. Fox

Francis E. Fox was born on May 22, 1909, in Wilmington, Del. In 1932, he received the A.B. degree at the Catholic University of America, in Washington, D. C. In 1934, this was followed by the M.Sc. in physics, and in 1937 by the Ph.D. from the same University.

Since 1936 Father Fox has been associated with the physics department at the Catholic University in various capacities, beginning as a research assistant. He became an instructor in physics in 1939, and at present holds the rank of associate professor of physics at that institution.

Since 1942, Father Fox has been associated with the naval research program of the David Taylor Model Basin. His research has been chiefly in the field of underwater sound and ultrasonics.

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For a biography and photograph of R. M. Bowie, see page 1049 of the August, 1948, issue of the Proceedings of the I.R.E.

Eugene G. Fubini

Eugene G. Fubini (A'36–SM'46) was born in Italy on April 19, 1913, and was educated at the Universities of Turin and Rome, Italy. He received the Ph.D. degree in 1933, Dr. Fubini did work on ultrahigh frequencies at the National Electrochemical Institute from 1936 to 1938. He joined the Columbia Broadcasting System staff in New York, N. Y., in 1939 as acting engineer-in-charge of the short-wave division. He later worked on design and installation of vhf links.

In December, 1942, Dr. Fubini joined the Radio Research Laboratory at Harvard University to undertake theoretical and experimental work. At the end of 1943, he was assigned as technical observer to the Mediterranean Army Air Force headquarters, and from September, 1944, to April, 1945, he was in charge of the RCM Division of the Operational Analysis Section of the Eighth Air Force.

Upon returning to the United States, Dr. Fubini became expert consultant to General McClelland, Air Chief of Operations. He joined Airborne Instruments Laboratory, Inc., Mineola, L. I., N. Y., in September, 1945, where he now heads the special devices section of the Laboratory.

◆

Donald C. Johnson

Donald C. Johnson attended Cornell and Columbia Universities and received the B.S. degree from the latter in 1941. He joined the staff of Sperry Gyroscope Company as an engineer, and served until the end of 1945. Early in 1946, he transferred to Reynolds Research, Glen Cove, N. Y., as senior chemical engineer. From December, 1946, to July, 1948, he worked at Airborne Instruments Laboratory, Inc., as an engineer in the special devices section. He is now affiliated with the Hazeltine Electronics Corporation.

◆

For a biography and photograph of James E. Hacke, see page 742 of the June, 1948, issue of the Proceedings of the I.R.E.

Joseph L. Hunter

Joseph L. Hunter (M'45) was born in New York, N. Y., on May 16, 1913. He received the B.S. degree in civil engineering from the Manhattan College in New York, N. Y., in 1934, the M.S. degree in physics from the Catholic University of America in 1936, and in 1940 was awarded the Ph.D. degree in physics, also from Catholic University.

Dr. Hunter was an instructor in physics at the John Carroll University in Cleveland, Ohio, from 1940 to 1941. During the war he served as a civilian with the signal corps at Camp Evans Signal Laboratory until 1943; thereafter, he was a member of the technical staff of the Bell Telephone Laboratories, New York, N. Y., until the end of the war. In 1945 he joined the staff of the Link Radio Company, and returned in 1946 to John Carroll University as a professor of physics. Since that time he has been chiefly engaged in supersonic research.

Dr. Hunter is a member of the American Physical Society, the American Institute of Electrical Engineers, and the Acoustical Society of America.

◆

John M. Kelso

John M. Kelso was born in Punxsutawney, Pa., on March 12, 1922. He received the A.B. degree from Gettysburg College in 1943, and the M.S. degree from The Pennsylvania State College in 1943, both in physics.

Since 1943, Mr. Kelso has been a part-time graduate student and a full-time employee at The Pennsylvania State College. Two years of this time were spent in teaching physics, and three years were spent with the Wind Tunnel Laboratory of the physics department. He is now employed by the ionosphere studies project in the electrical engineering department.

Mr. Kelso is a member of the American Physical Society, Sigma Pi Sigma, Pi Mu Epsilon, and an associate member of Sigma Xi.

◆

For a biography and photograph of George Sinclair, see page 1389, of the November, 1948, issue of the Proceedings of the I.R.E.

Contributors to Proceedings of the I.R.E.

Henry J. Riblet

Henry J. Riblet (A'45) was born at Calgary, Canada, on July 21, 1913. He received the B.S. degree in 1935, the M.S. degree in 1937, and the Ph.D. degree in mathematics in 1939, all from Yale University.

From 1939 to 1941 Dr. Riblet was instructor in mathematics at Adelphi College, and from 1941 to 1942 he was assistant professor of mathematics at Hofstra College. From 1942 to 1945 he was at the Radiation Laboratory, where he was in charge of that section of the antenna group which devoted its time to the design of omnidirectional, linear-array, broadband, and circularly polarized microwave antennas. He is now employed in the radar engineering group at the Submarine Signal Company.

He is a member of Sigma Xi, the American Mathematical Society, and the American Physical Society.

❖

David Middleton

David Middleton (S'42–A'44–M'45) was born on April 19, 1920, in New York, N. Y. In 1942 he received the A.B. degree in physics from Harvard University, followed by the A.M. degree in 1945, and the Ph.D. degree in 1947, obtained as a National Research Council predoctoral fellow in physics. During the last half of 1942 he was employed as a teaching fellow in electronics in the preradar training course carried on at that institution during the war. From December, 1942, through 1945, he was engaged as a research associate in the theory group of the Harvard Radio Research Laboratory, where much of his work dealt with noise and problems encountered in its use as radar and communication countermeasures.

Dr. Middleton is at present a research fellow in electronics at Harvard University, engaged in theoretical research in noise and electromagnetic theory problems. He is a member of Phi Beta Kappa, Sigma Xi, and the American Physical Society.

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Charles F. West

Charles F. West (M'48) was born in Oakland, Calif., on March 3, 1921. In the spring of 1942 he received the degree of B.S. in electrical engineering from the University of California at Berkeley. From 1942 to 1945 he was a staff member of the Radiation Laboratory at the Massachusetts Institute of Technology. During the early part of the war, and until the establishment of the British and French branches of the Radiation Laboratory, he served as a special overseas representative of the Office of Scientific Research and Development in London, prior to the British and French branches of the Radiation Laboratory.

Following the war, Mr. West was attached to the Dunham Laboratory of Electrical Engineering at Yale University. In 1946 he joined the Columbia Broadcasting System's color-television research group in New York.

Since June, 1947, Mr. West has been with the Raytheon Manufacturing Company at Waltham, Mass., where he has been engaged in the development of high-speed electronic digital-computing equipment. Since February, 1948, he has headed the computer equipment section.

Correspondence

Multifrequency Bunching in Reflex Klystrons*

W. H. Huggins has made an interesting theoretical study of mode competition in reflex klystrons.[1] The importance of the mode-competition problem in microwave oscillators in general gives his conclusions a particular significance. The simultaneous presence of oscillations of different frequencies on a transient or steady-state basis, the build-up of one oscillation as another dies out, etc., are phenomena associated with the character of the nonlinear circuit element in an oscillator and the frequency spectrum of its resonator. It should consequently be possible to analyze the behavior of such an oscillator in these respects on a more general basis; for instance, in terms of an expansion of the nonlinear conductance (or resistance) in powers of the voltage or current variable. In other words, I am suggesting that an extension of van der Pol's analysis of the nonlinear oscillator would contribute substantially to the qualitative understanding of the phenomena under discussion.[2,3] Van der Pol's treatment of the coupled-circuit triode oscillator illustrates the feasibility of this approach.

It is surprising (and regrettable) that radio engineers in general, and authors of handbooks and text books in particular, so far have made little use of the insight into the properties of oscillators that the nonlinear circuit analysis has given in such respects as initiation of oscillations, amplitude stability, synchronization with a small applied voltage, pulling in coupled systems, etc. The more complicated phenomena encountered in the microwave field due to the multiple resonances of distributed-constant systems make it even more desirable to take advantage of the powerful methods of the nonlinear circuit analysis.

Gunnar Hok
University of Michigan
Ann Arbor, Mich.

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* Received by the Institute, August 26, 1948.

[1] W. H. Huggins, "Multifrequency bunching in reflex klystrons," Proc. I.R.E. vol. 36, p. 624; May, 1948.

[2] B. van der Pol, "The nonlinear theory of electrica oscillations," Proc. I.R.E., vol. 22, p. 1051; September, 1934.

[3] N. Minorsky, "Introduction to Nonlinear Mechanics," Edward Brothers, Ann Arbor, Mich., 1947.

Modern Single-Sideband Equipment*

In regard to the paper "Modern Single-Sideband Equipment," which appeared in the August, 1948, issue of the Proceedings,[1] in which is treated the schematic of an oscillator developed by Mr. Prins, I beg herewith to inform you that it has just appeared to us that this same oscillator is already included in the U. S. patent number 2,321,354, 1943. Although the mentioned oscillator had been developed here independently, it appears that the idea of it was already known at that moment in the United States.

We should be very much obliged to you if you would publish this letter as soon as possible.

C. T. F. van der Wyck
Telegrafie en Telefonie
Centraal Laboratorium
Kortenaerkade II, Holland

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* Received by the Institute, August 30, 1948.

[1] C. T. F. van der Wyck, "Modern single-sideband equipment of the Netherlands postals telephone and telegraph," Proc. I.R.E., vol. 36, pp. 970–980; August, 1948.

Institute News and Radio Notes

Board of Directors

At the Board of Directors' Meeting held at the Institute on September 9, Ralph Bown was elected winner of the 1949 Medal of Honor. The following 31 members will also receive fellow awards, effective January 1, 1949:

H. A. Affel
K. C. Black
J. E. Brown
Cledo Brunetti
W. L. Carlson
P. S. Carter
F. F. d'Humy
J. N. Dyer
L. A. Gebhard
T. T. Goldsmith, Jr.
F. W. Grover
E. A. Guillemin
Ross Gunn
A. V. Haeff
L. C. Holmes
J. K. Johnson
S. R. Kantebet
W. B. Lodge
K. A. Mackinnon
H. F. Olson
L. S. Payne
L. M. Price
H. J. Reich
J. D. Reid
Karl Spangenberg
George Sterling
O. E. Strong
Franz Tank
Norris Tuttle
I. R. Weir
George O'Neill

The Danish Academy of Technical Sciences requested in a letter to President Shackelford, dated May 18, 1948, that the Institute recommend a candidate to receive the Valdemar Poulsen Gold Medal for 1948. The medal is awarded once every year in principle—although in practice it may be awarded every two years—to a radio engineer who has contributed significantly to the science or art of radio communication. This person is selected from recommendations made by "competent institutions in Denmark and abroad." Accordingly, the Institute Awards Committee suggested the name of G. W. Pierce.

The Institute was invited to send a representative to the inauguration reception for Dwight D. Eisenhower, new President of Columbia University. Dr. Goldsmith was asked to represent the Institute and accepted.

Executive Committee

A regular meeting of the Executive Committee was held at the Institute on September 8. C. G. Mayer, RCA European Technical Representative in London, was appointed IRE Representative on the IRE-AIEE International Liaison Committee.

EMPORIUM SECTION CONVENES WITH CHEMISTS

The third joint dinner meeting of the Pennsylvania-New York Western Border Section of the American Chemical Society and the Emporium Section of the IRE was held in Emporium, Pa., on September 16. An audience of 120 heard Albert C. Walker present his paper on "The Development of Piezoelectric Crystals," after which they saw a motion picture "Crystal Clear," prepared by J. J. Harley to illustrate Dr. Walker's paper.

The success of this meeting, as well as of the previous joint meetings, indicates the potential value to small or geographically isolated sections of the Institute of combined meetings with related scientific groups in order to facilitate the presentation of important developments by recognized authorities.

AGREEMENT ON SCREW THREADS STANDARDS

A joint conference of representatives of government committees and ranking industrial standardization groups from Great Britain, Canada, and the United States is scheduled to meet within the next three months in order to make final agreements on common standards for screw threads used on most types of threaded fasteners, including bolts and nuts.

It is planned to hold this conference at the National Bureau of Standards, which has actively co-operated in the attainment of this objective over a period of many years. The purposes of the joint conference are to assure complete agreement on all fundamentals and to celebrate the reaching of an agreement after years of negotiation.

Calendar of COMING EVENTS

1948 Southwestern I.R.E. Conference Dallas, Tex., Dec. 10–11, 1948

AIEE Symposium on High-Frequency Measurements, Washington, D. C., Jan. 10–12, 1949

American Physical Society Meeting, New York City, Jan. 27–29, 1949

1949 IRE National Convention, New York City, March 7–10, 1949

RMA—IRE Spring Meeting, Philadelphia, Pa., Apr., 25–27, 1949

1949 IRE Convention Plans Under Way

Under the guidance of George W. Bailey, Chairman, and the 1949 Convention Committee, arrangements for the 1949 IRE National Convention are moving ahead at top speed. All over the United States, Canada, and points even further distant, members are setting aside the second week in March of the new year for what promises to be one of the biggest and best conventions in the Institute's history. Indications show that the attendance should equal if not exceed that at the record 1948 convention. Again members are urged to make their hotel reservations well in advance because, although the hotel situation in New York City is less serious than it was, there is still a seasonal shortage of rooms. Desirable accommodations will be at a premium, and this is a convention no member will want to miss.

In response to the December 1 deadline set by D. B. Sinclair, Chairman of the Technical Program Committee, proposals for papers have been pouring in at a gratifying rate, and Dr. Sinclair assures members of a stimulating and varied papers program that will cover the entire gamut of subjects interesting to workers in the radio and electronics and allied fields. The complete technical program, including summaries of the papers scheduled and dates of presentation, will be printed in the February, 1949, issue of the PROCEEDINGS.

Dates have already been confirmed for most of the social activities. The annual meeting of the Institute will start the Convention on Monday, March 7, at 10:30 A.M. Later in the day a cocktail party from six to eight P.M. arranged by Walter Knoop, Chairman of the Cocktail Party Committee, will give the members and their families an opportunity to become better acquainted with each other. A sections meeting will follow the party.

The president's luncheon at 12:45 P.M. on Tuesday planned by R. D. Chipp, Chairman of that activity, will honor the incoming president, Stuart L. Bailey, who is himself on the Convention Committee. Wednesday's highlight will be the annual banquet at 6:45 P.M. Raymond F. Guy, toastmaster, will introduce Frank Stanton, president of the Columbia Broadcasting System. Dr. Stanton's topic will be "Television Today." Karl Spangenberg has been invited to deliver the speech of acceptance on behalf of the newly elected Fellows.

Although plans for a program of Women's Activities have not yet been consolidated, ladies who enjoyed themselves at previous Conventions can look forward to a program which bids fair to outdistance all the Institute's past successes. Ladies who have never before attended an IRE Convention have a treat in store for them.

Exhibit Manager William C. Copp has reported that 140 exhibitors have already taken 80 per cent of the available space at Grand Central Palace in which to display the latest in radio and electronic devices. By the time arrangements are completed, the total number of exhibitors is expected to reach a figure close to two hundred. Among the special features contemplated for this year's exhibits is a center devoted entirely to nuclear instrumentation.

Other members of the Convention Committee who are working along with Mr. Bailey in order to make this Convention an unforgettable one are Trevor H. Clark, Vice-Chairman; Austin Bailey, in charge of Finance; L. G. Cumming, Institute Activities; Clinton B. DeSoto, Printed Program; E. K. Gannett, Facilities; Virgil M. Graham, Publicity; Roscoe Kent, Hospitality; J. Harold Moore, Registration; and Emily Sirjane, Secretary.

The IRE Professional Group System—A Status Report

In the May, 1948, issue of the Proceedings of the I.R.E., on page 570, plans for the inauguration of a Professional Group System within the broad structure of The Institute of Radio Engineers were announced. Now, nine months later, many of those plans have been fulfilled, and the IRE Professional Group System is substantially an accomplished fact. Indeed, insofar as its acceptance by the membership and the degree to which the mechanics for its future operation have been charted are concerned it is an accomplished fact.

This seems an appropriate time, therefore, for a progress report directed to the Institute membership at large.

At this writing the following steps, envisioned by the Board of Directors when it first formally adopted the Group principle of organization at its March 25, 1948, meeting, have been realized: (1) Necessary amendments to the Bylaws of the Institute to effectuate the Group system have been adopted. (2) A permanent Professional Groups Committee, replacing the original ad hoc committee which did the initial planning and promotion of the plan, has been established. (3) A model constitution and bylaws for individual Groups has been prepared, incorporating the requisite tenets with sufficient latitude in construction to allow of alteration to satisfy the specialized requirements of individual groups. (4) A detailed and highly informative Manual for the guidance of would-be Group promoters has been prepared and published, and is available upon request. (Requests should be directed to the Technical Secretary of IRE.) (5) Most importantly of all, two Groups have been actively organized, and more are in the process of formation.

In accordance with the thoroughly democratic principles which were decreed for the Professional Group System from the time of its earliest inception in the minds of several IRE officials in 1947, the greatest part of this progress—and in particular all of the steps leading to the formation of the Groups so far established or in process—has sprung from the enthusiasm with which the membership at large greeted the original announcement. In this connection, it should be emphasized that, under the system as adopted, the promotion and organization of Groups is entirely a membership matter. Groups are organized by members; they are conducted by members; and their programs and activities are entirely guided by members. Once a group is established, any number of members within a section or locality can hold Group meetings and carry on authorized activities—even if the number is as small as two!

Principle of Group Organization

The principle of Group organization should be clear to all. It is not an idea novel with IRE. Some of the older engineering organizations have already adopted similar arrangements, as their fields of interest have enlarged with a rapidly expanding technology, and for them it has proved a successful mode of operation. The same problem that faced these societies has in recent years increasingly faced The Institute of Radio Engineers. Time was when our scope was fully indicated by our name, and all members of the organization had an essentially equal interest in the activities of all others. But in the past decade or so, and particularly in the postwar epoch, the amoeba-like multiplication of applications of radio and electronics has led to a divergence of fields of interests so great that the broadcast engineer has in common with the computer engineer mainly only the fundamental phenomena of the electron tube—and even that interest is an indirect association maintained largely through the person of yet another specialist, the designer of electron tubes. Similarly, the analyst of wave propagation phenomena can apprehend the problems of the man working with industrial heating equipment only to the extent that one wants radiation to escape and the other does not, while the audio man and the microwave man are a billion cycles removed from each other. These are, admittedly, only arbitrary and singular examples; but they can be elaborated in manifold fashion, and they illustrate the problems of community of interest in our recently incredibly expanded art.

The fundamental consideration, however, is that underneath it all each of these individual specialists is linked with each by his use of the same basic phenomena—electronics and radiation. That underlying binding force is the thing that is The Institute of Radio Engineers. It is essential to the self-interest of all that this force be maintained, that unity of purpose and of seeking shall be preserved, that research findings and design applications and, above all, professional zeal be sustained and disseminated and utilized to strengthen the whole, both in terms of organization and in extension of common knowledge. The question is how to accomplish this, and yet allow full exchange of mutual interest and information and enthusiasm among those most intimately connected with specific phases of the specialized directions in which this broad art of ours is growing.

To answer that question is the objective of the Professional Groups System.

Progress in Group Organization

As was stated above, two Groups already have been approved. The Audio Group was established on June 2, 1948, its purview being the "technology of communication at audio frequencies and with the audio-frequency portion of radio systems." Those interested in this Group should communicate with O. L. Angevine, Jr., c/o Stromberg-Carlson Co., Rochester, N. Y.

The second Group to be approved on July 7, 1948, was the Broadcast Engineers Group, encompassing not only "engineers associated with individual radio stations, broadcast networks, operating companies and broadcast consultants," but also including "government engineers associated with broadcasting, and engineers in commercial and other laboratories and manufacturing companies whose prime interest is in the development, design, production, operation and maintenance of broadcast equipment used by the various classes of broadcast stations." This professional group is intended to encompass the engineers of "any FM, AM, Facsimile, TV, International, Relay, Experimental, Emergency or any other associated class of broadcast stations." Those interested in this Group should communicate with Orrin W. Towner, c/o Radio Station WHAS, Louisville, Ky.

Other fields of activity in which interest in the formation of Groups has been expressed include wave propagation, antennas, telemetering, electronic computers, quality control, and standardization.

How to Organize a Group

For the benefit of those who are interested in organizing Groups in their particular fields of interest, the following step-by-step procedure has been outlined by the Professional Groups Committee. (Page numbers refer to the Group Manual.)

1. Write to the Executive Secretary of the Institute, for general information on the formation of Groups. (See page 1, Initial Inquiry, in the Manual.)
2. Communicate with others interested in the proposed field to get sufficient members willing to promote the Group and over 25 prepared to sign the petition. (See page 1, Promoting Petitioners.)
3. Prepare the petition. (See pages 1, 2, Preparing Petition, and pages 13, 22.)
4. Forward the petition to the Chairman, Committee on Professional Groups, through Institute Headquarters. (See page 2.)
5. Foward suggested names for the initial Administrative Committee to the Chairman, Committee on Professional Groups, through Institute Headquarters. (See pages 2, 14.)
6. After notification by Institute Headquarters of the appointment of the Administrative Committee by the Committee on Professional Groups, the Administrative Committee elects a chairman, notifies Institute Headquarters of the result of the election, and draws up a constitution. (See pages 2A, 15, and 19.)
7. Send the constitution to the Chairman, Committee on Professional Groups, through Institute Headquarters, for approval by that Committee and by the Executive Committee of the Institute. (See page 2A.)
8. The Administrative Committee draws up bylaws and appoints committees. (See pages 2A, 15, 16, and 21.)
9. Forward a copy of the bylaws and names of officers and committee chairmen to the Executive Secretary for his information. (See page 21.)

Note particularly that, once a petition bearing 25 signatures has been filed and a national Group approved in any field of interest, any number of members of any section, however small, may join the Group and hold meetings. As few as two members might conceivably hold local meetings. The only restriction is that all meetings of all Groups must be open to all members of IRE.

Industrial Engineering Notes[1]

Continued Use of Loran in Northeast Atlantic Asked

The State Department has notified the International Telecommunication Union that aids to radio navigation which are suitable for the Northeast Atlantic area and designed for operation in the allotted frequency bands under international regulations cannot be made available by July 1, 1949. The Department said that due to the great use now being made of loran in the area by both air and surface craft, it is the government's opinion that standard loran should be continued in the Northeast Atlantic area until an acceptable substitute which can be agreed upon internationally is in operation.

New Transducer Development

A highly sensitive mechano-electrical transducer, which transforms slight displacements into large changes of resistance, current, or voltage, is being developed by the Bureau of Standards. The active element of the device is a helical or conical spring wound in such a way that the initial tension varies slightly along its length. Thus, when the ends of the spring are pulled apart, the turns separate one by one, rather than simultaneously.

The October issue of the Technical New Bulletin, Standards Bureau publication, has printed a description of the new development. Copies of this monthly magazine may be obtained at 10 cents each from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

FCC Issues Life-Saving Revisions

The FCC has issued a public notice (No. 27112) containing an outline of the revisions of the International Convention for the Safety of Life at Sea, 1929, which were adopted at London last June, and which become effective on January 1, 1951. Copies of the outline and further information on the radio aspects of the revised Convention may be obtained from the Secretary of the FCC, Washington 25, D. C.

Television and Radio Production and Sales Rise as Excise Tax Collections Fall

RMA member-companies manufactured 64,953 television receivers in August, thus setting up a new monthly record which represents an increase of almost 10,000 over the July output. FM-AM set production totalled 110,879 in August, the largest output of this type of receiver since last March. Radio receiver production of all types totalled 870,044 in August as compared with 627,349 in July. Production of automobile and portable radios aggregated 256,594 and 178,323, respectively.

Indicative of the sharp increase in television receiver production during the first half of 1948, sales of cathode-ray tubes to set manufacturers rose more than 68 per cent during the second quarter over sales in the first quarter. During the first six months of 1948 cathode-ray tube sales to manufacturers totalled 426,469, with a value of $10,250,218, as compared with sales during the entire year of 1947 of 253,035 units, valued at $7,218,358.

With U. S. government purchases accounting for 71 per cent of the total, sales of radio and television transmitting and communications equipment by RMA member-companies aggregated $50,318,006 during the second quarter of 1948, and brought sales of this type to $80,346,321 for the first six months of this year.

August collections of the 10 per cent excise tax on radios and phonographs and certain of their components dropped below the collections of both July, 1948, and August, 1947, the U. S. Bureau of Internal Revenue reported. Collections of the radio excise tax in August amounted to $3,927,009.08, as compared with $4,060,785.34 last July and $5,084,018 in August a year ago.

FM Developments

The FCC has denied petitions presented by Major Edwin H. Armstrong and the FM Association, seeking to reopen the record in proceedings concerning the sharing of television channels. Major Armstrong's petition requested that the FCC order of May 5, 1948, be reconsidered "insofar as it denies requests made at the hearing that a portion of the 44- to 50-Mc band be allocated to FM broadcast relay purposes, and insofar as it required FM broadcast stations operating in the 44- to 50-Mc band to discontinue operation by December 31, 1948." The FM petition sought to extend the FCC proposed discontinuance date of FM operation in the 44- to 50-Mc band until December 31, 1950.

Since the last issue of the Proceedings, 30 FM stations have gone on the air, bringing the total to 673 stations, which includes 24 noncommercial outlets. New stations have begun operation in the following states:

Ala., Mobile (WMOB-FM), Montgomery (WMGY-FM); *Cal.*, San Diego (KFSD-FM); *D. C.*, Washington (WOL-FM and WCFM); *Ga.*, Atlanta (WSB-FM) and La Grange (WLAG-FM); *Iowa*, Des Moines (KCBC-FM); *Ill.*, Chicago (WMAQ-FM) and Woodstock (WILA); *Ind.*, Warsaw (WRSW); *Ky.*, Ashland (WCMI-FM); *Md.*, Cumberland (WTBO-FM); *Mass.*, Boston (WNAC-FM), Lowell (WLLH-FM), Lynn (WLYN-FM); *N. Y.*, Endicott (WENE-FM), Massena (WMSA-FM), New Rochelle (WGNR), Troy (WEVR); *Ohio*, Canton (WAND-FM), Columbus (WHKC-FM); *Pa.*, Uniontown (WNIQ); *Tex.*, Longview (KLTI-FM); *Wash.*, Tacoma (KTNT); *W. Va.*, Parkersburgh (WPAR-FM); and *Wis.*, Madison (WISC-FM), St. Cloud (KFAM-FM), and Wisconsin Rapids (WFHR-FM).

Canadian Radio News

The Canadian RMA Service Committee has published four bulletins for service technicians: "The Treatment of Hum in Radio Receivers," "FM Servicing" (in two parts), "Capacitor Colour Coding," and "Antennae." The earlier bulletin, "Trouble Shooting in Radio Receivers," has been reprinted, and the Committee is now preparing bulletins on "Alignment" and "An Open Letter to Radio Service Technicians," the latter of which covers basic theory . . . . R. M. Brophy, Chairman of the Canadian RMA Industrial Mobilization Committee, has been requested by the Industrial Defence Board and Canadian Ordnance Association to organize and convene an Industrial Defence Preparedness Committee on Communications and Electronics. Its principal task will be to effect liaison among the Armed Services, the arsenals, and industry. . . . Radio set sales in Canada have been dropping. Sales for the first seven months of this year totalled 224,762 units worth $20,069,485, as against 429,234 units worth $27,707,066 for the first seven months of 1947 . . . . Imports and exports also have been decreasing. During the first six months of this year, 17,800 sets valued at $206,988 were imported, as compared with 44,775 sets valued at $1,559,517 imported during the first half of 1947. Canada exported 441 sets worth $15,146 for the first six months of 1948; whereas she exported 21,597 sets worth $781,672 in the first half of 1947 . . . . One hundred and twenty-five members and guests attended a joint IRE-Canadian RMA Golf Tournament and Dinner at the Cutten Fields Golf Club in Guelph, Ont., on September 17, J. R. Longstaffe, a member of both the RMA and the Toronto Section of the IRE, acted as master of ceremonies and presided at the dinner and evening program.

RMA Holds Conference; Publishes Radio Booklet

Aggressive action to develop television and to expedite the adoption by the government of a mobilization plan of the radio and electronics industry highlighted a three-day RMA fall conference from October 6 to 8, at the Roosevelt Hotel in New York City.

Among the other matters on its agenda, the Board of Directors authorized legal action to contest the validity of a Pennsylvania state license tax on taverns equipped with television receivers, established a special committee to confer with the FCC regarding pending study of future expansion of television services into the UHF band, authorized President Max F. Balcolm to set up a committee representing the Set, Tube, and Transmitter Divisions, and authorized the Engineering Department to work with the Export Committee in the promotion of American television standards and equipment in foreign countries.

The RMA has published a booklet, "Classroom Radio Receivers," which is being distributed to 45,000 educators throughout the country. The work of the U. S. Office of Education and the RMA Joint Committee on Specifications for School Audio Equipment, the pamphlet is the third in a series of such studies, the other two being "School Sound Systems" and "School Sound Recording and Playback Equipment."

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[1] The data on which these Notes are based were selected, by permission, from "Industry Reports," issues of September 17 and 24, and October 1, 11, and 15, published by the Radio Manufacturers' Association of America; and from the September 14 issue of "News," published by the Radio Manufacturers' Association of Canada. The helpful attitude of both of these organizations is hereby gladly acknowledged.

Sections

Chairman		Secretary
W. A. Edson Georgia School of Tech. Atlanta, Ga.	ATLANTA December 17	M. S. Alexander 2289 Memorial Dr., S.E. Atlanta, Ga.
	BALTIMORE	J. W. Hammond 4 Alabama Ct. Baltimore 28, Md.
John Petkovsek 1015 Ave. E Beaumont, Texas	BEAUMONT—PORT ARTHUR	C. E. Laughlin 1292 Liberty Beaumont, Texas
R. W. Hickman Cruft Laboratory Harvard University Cambridge, Mass.	BOSTON	A. F. Coleman Mass. Inst. of Technology 77 Massachusetts Ave. Cambridge, Mass.
G. E. Van Spankeren San Martin 379 Buenos Aires, Arg.	BUENOS AIRES	A. C. Cambre San Martin 379 Buenos Aires, Arg.
J. F. Myers 249 Linwood Ave. Buffalo 9, N. Y.	BUFFALO-NIAGARA December 15	R. F. Blinzler 558 Crescent Ave. Buffalo 14, N. Y.
G. P. Hixenbaugh Radio Station WMT Cedar Rapids, Iowa	CEDAR RAPIDS	V. R. Hudek Collins Radio Co. Cedar Rapids, Iowa
K. W. Jarvis 6058 W. Fullerton Ave. Chicago 39, Ill.	CHICAGO December 17	Kipling Adams General Radio Co. 920 S. Michigan Ave. Chicago 5, Ill.
C. K. Gieringer 3016 Lischer Ave. Cincinnati, Ohio	CINCINNATI December 14	F. W. King RR 9 Box 263 College Hill Cincinnati 24, Ohio
F. B. Schramm 2403 Channing Way Cleveland 18, Ohio	CLEVELAND December 23	J. B. Epperson Box 228 Berea, Ohio
Warren Bauer 376 Crestview Rd. Columbus 2, Ohio	COLUMBUS January 14	George Mueller Electrical Eng. Dept. Ohio State University Columbus, Ohio
S. E. Warner Aircraft Electronics Assoc. 1031 New Britain Ave. Hartford 10, Conn.	CONNECTICUT VALLEY December 16	H. L. Krauss Dunham Laboratory Yale University New Haven, Conn.
J. G. Rountree 4333 South Western Blvd. Dallas 5, Texas	DALLAS-FT. WORTH	J. H. Homsy Box 5238 Dallas, Texas
George Rappaport 132 East Court Harshman Homes Dayton 3, Ohio	DAYTON December 16	C. J. Marshall 1 Twain Place Dayton 10, Ohio
C. F. Quentin Radio Station KRNT Des Moines 4, Iowa	DES MOINES-AMES	F. E. Bartlett Radio Station KSO Old Colony Bldg. Des Moines 9, Iowa
A. Friedenthal 5396 Oregon Detroit 4, Mich.	DETROIT December 17	N. C. Fisk 3005 W. Chicago Ave. Detroit 6, Mich.
E. F. Kahl Sylvania Electric Products Emporium, Pa.	EMPORIUM	R. W. Slinkman Sylvania Electric Products Emporium, Pa.
W. H. Carter 1309 Marshall Ave. Houston 6, Texas	HOUSTON	J. C. Robinson 1422 San Jacinto St. Houston 2, Texas
R. E. McCormick 3466 Carrollton Ave. Indianapolis, Ind.	INDIANAPOLIS	Eugene Pulliam 931 N. Parker Ave. Indianapolis, Ind.
Karl Troeglen KCMO Broadcasting Co. Commerce Bldg. Kansas City 6, Mo.	KANSAS CITY	Mrs. G. L. Curtis 6005 El Monte Mission, Kan.
R. W. Wilton 71 Carling St. London, Ont., Canada	LONDON, ONTARIO	G. H. Hadden 35 Becher St. London, Ont., Canada
Walter Kenworth 1427 Lafayette St. San Gabriel, Calif.	LOS ANGELES October 19	R. A. Monfort L. A. Times 202 W. First St. Los Angeles 12, Calif.
O. W. Towner Radio Station WHAS Third & Liberty Louisville, Ky.	LOUISVILLE	D. C. Summerford Radio Station WKLO Henry Clay Hotel Louisville, Ky.
F. J. Van Zeeland Milwaukee School of Eng. 1020 N. Broadway Milwaukee, Wis.	MILWAUKEE	H. F. Loeffler Wisconsin Telephone Co. 722 N. Broadway Milwaukee 1, Wis.
K. R. Patrick RCA Victor Div. 1001 Lenoir St. Montreal, Canada	MONTREAL, QUEBEC January 12	S. F. Knights Canadian Marconi Co. P.O. Box 1690 Montreal, P. Q., Canada
L. A. Hopkins, Jr. 1711 17th Loop Sandia Base Branch Albuquerque, N. M.	NEW MEXICO	T. S. Church 637 La Vega Rd. Albuquerque, N. M.
J. W. McRae Bell Telephone Labs. Murray Hill, N. J.	NEW YORK January 5	R. D. Chipp DuMont Telev. Lab. 515 Madison Ave. New York, N. Y.
C. G. Brennecke Dept. of Electrical Eng. North Carolina State College Raleigh, N. C.	NORTH CAROLINA-VIRGINIA	C. M. Smith Radio Station WMIT Winston-Salem, N. C.
W. L. Haney 117 Bourque St. Hull, P. Q.	OTTAWA, ONTARIO November 16	G. A. Davis 78 Holland Ave. Ottawa, Canada
A. N. Curtiss Radio Corp. of America Camden, N. J.	PHILADELPHIA January 6	C. A. Gunther Radio Corp. of America Front & Cooper Sts. Camden, N. J.
M. A. Schultz 635 Cascade Rd. Forest Hills Borough Pittsburgh, Pa.	PITTSBURGH January 10	E. W. Marlowe Union Switch & Sig. Co. Swissvale P.O. Pittsburgh 18, Pa.
O. A. Steele 1506 S.W. Montgomery St. Portland 1, Ore.	PORTLAND	F. E. Miller 3122 S.E. 73 Ave. Portland 6, Ore.
A. V. Bedford RCA Laboratories Princeton, N. J.	PRINCETON	L. J. Giacoletto 9 Villa Pl. Eatontown, N. J.
K. J. Gardner 111 East Ave. Rochester 4, N. Y.	ROCHESTER December 16	Gerrard Mountjoy Stromberg-Carlson Co. 100 Carlton Rd. Rochester, N. Y.
E. S. Naschke 1073-57 St. Sacramento 16, Calif.	SACRAMENTO	W. F. Koch 1340 33rd St. Sacramento 14, Calif.
G. M. Cummings 7200 Delta Ave. Richmond Height 17, Mo.	ST. LOUIS	C. E. Harrison 818 S. Kings Highway Blvd. St. Louis 10, Mo.
C. L. Jeffers Radio Station WOAI 1031 Navarro St. San Antonio, Texas	SAN ANTONIO	H. G. Campbell 233 Lotus Ave. San Antonio 3, Texas
C. N. Tirrell U. S. Navy Electronics Lab. San Diego 52, Calif.	SAN DIEGO January 4	S. H. Sessions U. S. Navy Electronics Lab. San Diego 52, Calif.
F. R. Brace 955 Jones St. San Francisco 9, Calif.	SAN FRANCISCO	R. A. Isberg Radio Station KRON 901 Mission St. San Francisco 19, Calif.
W. R. Hill University of Washington Seattle 5, Wash.	SEATTLE January 13	W. R. Triplett 3840—44 Ave. S.W. Seattle 6, Wash.
F. M. Deerhake 600 Oakwood St. Fayetteville, N. Y.	SYRACUSE	S. E. Clements Dept. of Electrical Eng. Syracuse University Syracuse 10, N. Y.
A. R. Bitter 4292 Monroe St. Toledo 6, Ohio	TOLEDO	J. K. Beins 435 Kenilworth Ave. Toledo 10, Ohio

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G. P. Adair 1833 "M" St. N.W. Washington, D. C.	WASHINGTON	H. W. Wells Dept. of Terrestrial Magnetism Carnegie Inst. of Washington Washington, D. C.
J. C. Starks Box 307 Sunbury, Pa.	WILLIAMSPORT	R. G. Petts Sylvania Electric Products, Inc. 1004 Cherry St. Montoursville, Pa.

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A. M. Glover RCA Victor Div. Lancaster, Pa.	LANCASTER (Philadelphia Subsection)	C. E. Burnett RCA Victor Div. Lancaster, Pa.
H. A. Wheeler Wheeler Laboratories 259–09 Northern Blvd. Great Neck, L. I., N. Y.	LONG ISLAND (New York Subsection)	M. Lebenbaum Airborne Inst. Lab. 160 Old Country Rd. Box 111 Mineola, L. I., N. Y.
L. E. Hunt Bell Telephone Labs. Deal, N. J.	MONMOUTH (New York Subsection)	G. E. Reynolds, Jr. Electronics Associates, Inc. Long Branch, N. J.
J. B. Minter Box 1 Boonton, N. J.	NORTHERN N. J. (New York Subsection)	A. W. Parkes, Jr. 47 Cobb Rd. Mountain Lakes, N. J.
A. R. Kahn Electro-Voice, Inc. Buchanan, Mich.	SOUTH BEND (Chicago Subsection) December 16	A. M. Wiggins Electro-Voice, Inc. Buchanan, Mich.
R. M. Wainwright Elec. Eng. Department University of Illinois Urbana, Illinois	URBANA (Chicago Subsection)	M. H. Crothers Elec. Eng. Department University of Illinois Urbana, Illinois
S. S. Stevens Trans Canada Airlines Box 2973 Winnipeg, Manit., Canada	WINNIPEG (Toronto Subsection)	S. G. L. Horner Hudson's Bay Co. Brandon Ave. Winnipeg, Manit., Canada

Books

Microwave Transmission Design Data, by Theodore Moreno

Published (1948) by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 18, N. Y., 241 pages, 6-page index, x pages, 92 figures. $6\frac{1}{2} \times 9\frac{1}{4}$. $4.00.

This volume, intended as a reference handbook for radio engineers working with microwave transmission lines and associated components, is a greatly revised version of a wartime confidential publication of the same title, put out in 1944 by the Sperry Gyroscope Co. Such matters as generation, reception, propagation, and measurement techniques are not included, but several chapters pertaining to elementary basic theory have been added, as well as considerable new technical information to bring the book up-to-date. On the other hand, some data have been left out, and all graphs have been reduced in size and redrawn with fewer co-ordinate lines. Perhaps the publisher saved a few pages in this way, but he made the book a less useful tool.

The principal subjects covered are transmission-line relations and charts; general formulas for coaxial lines and waveguides; coaxial-line and waveguide obstacles, junctions, and other structures; and cavity resonators. The extensive tables listing the dimensions and properties of standard coaxial lines and waveguides, as well as the table giving the microwave properties of over a hundred dielectric materials, should prove very valuable to the practicing microwave engineer.

The author has covered his topics well and produced a text that is clearly written and easily understandable. Although there are some typographical errors, very few should result in confusion. More confusing is the inconsistent use of units, which is particularly troublesome in the chapter on cavity resonators. The consistent use of mks units throughout the volume would have made it an even more useful guide.

SEYMOUR B. COHN
Sperry Gyroscope Co.
Great Neck, N. Y.

Microwave Duplexers, by Louis D. Smullin and Carol G. Montgomery

Published (1948) by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 18, N. Y. 430 pages, 7-page index, xiv pages, 392 figures. $6\frac{1}{2} \times 9\frac{1}{4}$. $6.50.

This is another of the MIT Radiation Laboratory series of books and, like the others, it attempts to summarize within the confines of a single volume the information accumulated at the Radiation Laboratory during the war years. The rapid progress made during this period, together with the emphasis on results rather than on understanding, inevitably lead to the accumulation of engineering information rather than of scientific knowledge. This trend was particularly pronounced in the field of microwave duplexers, where the needs for operating devices were acute and where the poorly understood gaseous-discharge TR switch was found to be surprisingly effective. The authors are to be commended for the excellent job which they have done in compiling this information. It would be manifestly unfair to criticize them personally for the rather unsatisfactory state of knowledge which is thereby revealed. As a matter of fact, the advances made during the war years in the engineering applications of gas discharges were so substantial that a well-written summary such as this is a real aid to anyone wishing to conduct a more leisurely inquiry into the fundamental reasons for the observed effects.

After an introductory chapter, the book considers in turn the linear theory of high-Q TR tubes, the band-pass TR tubes, and the characteristics of ATR switches at low levels. This is followed by a rather long chapter on microwave gas discharges which covers those scientific aspects of the TR switch which are characteristic of this device and are not common to other microwave devices. Chapter six discusses the operation of TR and ATR tubes at high powers, and considers this subject largely from the user's point of view. The principles of branched duplex circuits are then discussed, using matrix notation. This chapter constitutes a worth-while contribution to the general solution of complex branching circuits. The design details of practical branched duplexers are next described, and some consideration given to balanced duplexers. The concluding chapter on measurement techniques is a good summary of some of the more important aspects of this problem.

The joint effort of six contributing authors, the volume inevitably is inconsistent in spots. Considering the fact that a whole chapter has already been devoted to the linear theory, the analysis starting on page 71 is surprisingly elementary. Furthermore, the authors of chapter two and chapter three do not agree on the equivalence or lack of equivalence of different methods of defining Q, as may be seen by comparing the material on pages 10 and 72. Such inconsistencies are more apparent in the earlier chapters of the book, where the chapter order makes it necessary to assume some knowledge of material which is not defined until a later chapter. There is also a certain amount of looseness in terminology to be noted, such as the frequent use of the word "susceptance" to mean "admittance."

On the whole, however, the book is very well written, and a high standard of excellence in style, format, and typography is maintained throughout. The authors have been most fair in their assignment of credit to persons outside of the Radiation Laboratory. Nevertheless, there is a certain lack of historical perspective evident in the book, and a persistent implication that the Radiation Laboratory was the fountainhead of all knowledge. But, with the few defects already mentioned, the book is a "must" for anyone interested in the field.

A. L. SAMUEL
University of Illinois
Urbana, Ill.

Microwave Transmission Circuits, edited by George L. Ragan

Published (1948) by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 18, N. Y. 624 figures, 45 tables, 716 pages, 9-page index, xvii pages. 6×9 inches. $8.50.

This book, number nine in the Radiation Laboratory Series of 28 volumes, deals with the problems of power transmission from one place to another at microwave frequencies, and its contents are applicable to almost all of the problems that come up in the design of microwave circuits. Seven authors have combined to produce a well-written and interesting volume, of value to both the scientist and the layman. Copious illustrations and tables supplement the text. Taking into consideration the amount of time between the preparation of a book and its publication (about a year), the mathematical treatment is up-to-date.

In the first two chapters, Mr. Ragan defines the microwave region referred to in this volume as extending from 2 to 25 kM, and offers a discussion of elementary line theory. The second chapter is presented with especial clarity: after each step of new theory a short interpretation of the terms of the equations developed are given. Divided into four parts, the chapter includes conventional line theory; transmission lines as guides for electromagnetic waves; transmission-line charts and impedance-matching, and design procedure.

R. M. Walker covers materials and construction techniques in chapter three. He discusses metallic materials, finishes and electroplating, dielectric materials, and pressurization problems. As far as this reviewer knows, a great deal of this material is completely new, in that it has not been published before.

In chapter four, Mr. Ragan and Mr. Walker both discuss rigid transmission lines, covering coaxial lines; waveguide couplings; corners, circular bends and twists; impedance matching; pressurizing windows; and voltage breakdown.

Chapter five is again presented by two authors, F. E. Ehlers and F. P. Worrell, who give an up-to-date review of flexible coupling units and lines.

In chapter six Mr. Ragan covers transition units, including transitions for one coaxial line to another, coaxial to waveguide, one waveguide to another, and one waveguide mode to another. Mr. Ehlers and F. L. Neimann discuss approximately twelve different kinds of motional joints in chapter seven; and in chapter eight Neimann and Ragan cover tuners, power dividers, and switches, describing about thirteen different kinds of tuners.

The concluding two chapters by R. M. Fano and A. W. Lawson discuss the theory of microwave filters and design of microwave filters, each of the chapters being followed by a bibliography. Using the information contained in these last chapters, the reader should be able to design microwave filters.

The one significant defect in the book is its inadequate index, in that the table of contents is the more complete reference. Otherwise, it is an excellent and useful presentation of the subject.

ALLEN F. POMEROY
Bell Telephone Laboratories
New York 14, N. Y.

Antenna Manual, by Woodrow Smith

Published (1948) by Editors and Engineers, 1300 Kenwood Rd., Santa Barbara, Calif. 301 pages, 5-page index, iii pages, 155 figures. 6½×9½.

A clearly written, well-illustrated book, the "Antenna Manual" is couched in simple language manifestly addressed to the amateur experimenter.

The first quarter of the book is devoted to an elementary discussion of propagation, ionosphere reflection, and related subjects. Only about 40 per cent of the manual is actually devoted to antennas. This portion is a compilation of descriptive material on the construction and salient characteristics of antennas, most of which are varieties appealing to the amateur. The antennas are classified into low, medium, high, very-high, and ultra-high-frequency types. No information is included on microwave antennas or waveguides.

The remaining thirty-five per cent of the book has chapters on transmission lines, coupling methods, and measurements. Throughout, the discussion is general, with the accent on the practical. Occasionally the explanations are over-simplified, and even such basic aids as transmission-line impedance charts are omitted.

The book is nonmathematical, including only four very simple equations, and contains only two references. It is regrettable that the author has used considerable material without indicating its source. As a result, much of the data lacks authoritativeness, and its value is depreciated in many instances.

In spite of this minor deficiency, the book fills a definite need, and is recommended for those desiring a readable, elementary, and concise discussion of some of the more practical aspects of radio propagation antennas.

JOHN D. KRAUS
Ohio State University
Columbus, O

IRE People

William L. Everitt (A'25–M'29–F'38), one of America's foremost authorities on electronics, has been appointed Dean of the University of Illinois' College of Engineering. The appointment will be effective on September 1, 1949.

Born in Baltimore, Md., on April 14, 1900, Professor Everitt received the E.E. degree from Cornell University in 1922, acting meanwhile as instructor of electrical engineering during the last two years of his studies there. In 1922 he joined the North Electric Manufacturing Co. of Galion, Ohio, where he took charge of the design and development of their relay automatic public switchboard exchanges. Two years later he became an instructor in electrical engineering at the University of Michigan, remaining there until he received the M.S. degree in 1926 when he went to Ohio State University to teach communication engineering. Ohio State awarded him the Ph.D. degree in 1933 and the following year promoted him to a full professorship. Meanwhile, during the summer vacations, from 1925 to 1930, he had served with the department of development and research of the American Telephone and Telegraph Co. and also acted as consultant for a number of broadcast stations and radio manufacturing companies.

In 1942 Dr. Everitt was granted a leave of absence from the University in order to act as Director of Operational Research with the U. S. Army Signal Corps. Three years later, while he was still working with the Army, he was appointed head of Ohio State's electrical engineering department in absentia. Upon the conclusion of the war he resumed his work with the University.

Dr. Everitt is the author of a number of texts and articles on electrical engineering. A former director of the Institute, and a member of numerous Committees, he was President in 1945. He is a Fellow of the AIEE and a member of the National Council of Tau Beta Pi, Sigma Xi, and Eta Kappa Nu.

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C. Russell Cox (A'29–SM'48), formerly sales manager and chief engineer of the Andrew Corp. in Chicago, has been chosen for the newly created office of director of sales and engineering.

Born in Chicago, Ill., in 1916, Mr. Cox attended the University of Chicago, from which he received the B.S. degree in 1937 and the M.S. degree in physics in 1939. The following year he joined the Andrew Corp.

Mr. Cox is the author of numerous technical papers on coaxial transmission lines. He is a member of Phi Beta Kappa, and has served on the RMA subcommittees to develop standards on coaxial transmission lines.

A. Hoyt Taylor (M'16–F'30), one of the U. S. Government's most distinguished scientists, has retired after more than 31 years of continuous service to the Navy. In stepping down from the Naval Research Laboratory's top civilian position—Chief Consultant for Electronics—Dr. Taylor brings to a close a half-century devoted to research in radio.

Dr.Taylor was born in Chicago on New Year's Day in 1879. While in high school at Evanston, Ill., he became interested in electrical engineering and decided to specialize in that field at Northwestern University, from which he received the B.S. degree in 1902. After graduation, he became an instructor in physics, first at Michigan State College and later at the University of Wisconsin.

In 1908 he returned to his studies, qualifying for the doctorate at Goettingen in Germany. The following year he joined the University of North Dakota as head of the physics department. He remained there for eight years, concentrating on experimental work in radio.

When the entry of the United States in the first World War seemed imminent, good radio engineers were at a premium. The Navy persuaded Dr. Taylor to apply for a Naval Reserve Commission and he was sworn in as a lieutenant shortly before war was declared. For almost five years he remained on active duty, advancing to the rank of commander. After the war he assumed direction of the U. S. Naval Aircraft-Radio Laboratory.

When the Naval Research Laboratory was established in 1923, the staff of its original radio division was formed by combining the Naval Aircraft Laboratory with two other experimental units then located in Washington. Dr. Taylor was appointed superintendent, and in this position significantly influenced the entire development of U. S. naval radio. It was largely as a result of successful experiments and demonstrations carried out at the laboratory that the U. S. Navy led the world in adopting high frequencies for improving its communication system. Dr. Taylor's own contributions to radio include the development and the application of the propagation of high-frequency energy, the quartz crystal oscillator, and high- and super-frequency radio communication systems.

It is, however, for his share in the discovery and development of radio-detection techniques now called radar that Dr. Taylor will probably be best remembered. Beginning as early as 1922, he and an assistant conducted a series of experiments which disclosed the amazing possibility of detecting and tracking targets by radio waves. Later the Naval Research Laboratory's radio engineers under Dr. Taylor's guidance perfected the weapon which was to have such a profound effect on U. S. Naval tactics in World War II. For this work he was awarded the U. S. Medal for Merit in 1944.

Aside from his achievements for the Navy, Dr. Taylor has won wide recognition in the world of science. In 1927 he was awarded the IRE's Morris Liebmann Memorial Prize; in 1929 he was elected President of the Institute; in 1942 he received the IRE's Medal of Honor, and in the same year was selected to receive the Franklin Institute's John Scott Medal. He is a fellow of the American Physical Society, the American Association for the Advancement of Science, and the AIEE; and a member of the Geophysical Society.

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L. Grant Hector (A'26–SM'39) has been elected vice-president in charge of technical operations of the Sonotone Corp., where he has been employed as director of research since the end of the war.

Dr. Hector was born on December 15, 1894, at Clarendon, Pa. In 1920 he received the A.B. degree from Oberlin College. While he was doing graduate work at Oberlin, Dr. Hector worked as a private research assistant to A. P. Wills, leaving in 1922, when he received the M.A. degree to become an instructor of physics at Oberlin. The following year he became Tyndall Fellow at Columbia and, upon being awarded the doctorate in 1924, he became an assistant professor of physics at the University of Buffalo. Three years later he was promoted to full professor.

After engaging in the development of the proximity fuze for the U. S. Government's Office of Scientific Research and Development from 1941 to 1943, Dr. Hector jointed the National Union Radio Corp. as director of engineering. At the same time he worked as a dollar-a-year consultant on the production of subminiature radio tubes used in the radio proximity fuze for the War Production Board from 1943 to 1945. When the war was over, Dr. Hector joined the Sonotone Laboratories in Elmsford, N. Y. to work on the research and development of tiny vacuum tubes for peacetime use in hearing aids.

Dr. Hector has written a number of papers, articles, and books dealing with magnetic, dielectric, and acoustical measurements by electronic techniques. Text books by Dr. Hector include "Modern Radio Receiving" (1927), "Introductory Physics" (1933), and "Electronic Physics" (1943). His papers and articles have been delivered before the American Physical Society and the International Scientific Union and have been printed in the PROCEEDINGS OF THE I.R.E., *Physical Review*, and the *Review of Scientific Instruments*. He is a fellow of the American Physical Society and the American Association for the Advancement of Science, a member of the Acoustical Society of America and of Sigma Xi.

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Joseph P. Maxfield (SM'47) formerly associated with the Bell Telephone Laboratories for thirty-one years, has accepted the position of Superintending Scientist at the U. S. Navy Electronics Laboratory in San Diego, Calif., where he will be in charge of the laboratory's scientific and technical research in the field of radio, radar, and sonar.

A distinguished pioneer in the field of electronics, Mr. Maxfield has played a leading role in the development of radio broadcasting, motion-picture sound systems, and record reproducing equipment. After receiving the Bachelor of Science degree from the Massachusetts Institute of Technology in 1910, Mr. Maxfield taught there for four years. He then joined the engineering department of the Western Electric Co. to engage in research work on the physical and electrical properties of microphone contacts. An outgrowth of this work was the "Maxfield Transmitter," one of the first microphones used in radio broadcasting.

During the first World War, Mr. Maxwell helped develop methods for the acoustic detection of aircraft and the sound ranging of artillery, and resumed work on this problem with a staff of twenty-five leading scientists and engineers at Duke University during World War II. From 1919 to 1926 he made significant contributions to the art of transmitting, recording, and reproducing high-quality sound. The techniques which he evolved as a result of this work have been applied directly to public-address systems, the design of broadcasting studios, the development of microphone techniques, and the adaptation of sound recording to motion pictures. In the field of home musical entertainment, Mr. Maxfield directed engineering and research on the orthophonic phonograph for the Victor Talking Machine Co.

Upon his return to Bell in 1929, Mr. Maxfield joined the Electrical Research Products, Inc., and made many contributions which advanced the quality of sound motion pictures during the ensuing years. From 1936 to 1943 Mr. Maxfield was director of commercial engineering of ERPI and was responsible for developing equipment to measure, analyze, and record sound and vibration. He also was responsible for a study of airplane vibration and flutter, work requested for the Civil Aeronautics Authority, and he designed the acoustic treatment of several buildings at the New York World's Fair.

In 1942 Mr. Maxfield returned to the Bell Laboratories, but six months later was given a leave of absence to become director of the National Defense Research Committee's Division of Physical Research at Duke University. There he and his staff made significant contributions to the problem of sound ranging of artillery. Returning again to Bell Laboratories in 1944, this time as a member of the Acoustic Products Development Group, he worked with liveness as related to sound-pickup techniques until his retirement in the fall of 1947. In 1948 he became associated with the Altec-Lansing Corp. as a consulting engineer.

Mr. Maxfield is a Fellow of the American Physical Society, and a member of the AIEE, the Acoustic Society of America, and the Society of Motion Picture Engineers. He is the author of numerous papers and articles on acoustics, electrochemistry, and physics, and the inventor of numerous devices used in telephony, radio broadcasting, and the electrical recording and reproduction of sound on film.

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John S. Brown (A'44–M'45), former assistant chief engineer at the Andrew Corp., has been promoted to chief engineer. Associated with the company since 1943, Mr. Brown has been active in development and manufacturing design work on transmission lines and antenna equipment.

Louis Cohen, (F'15), distinguished engineer, consultant, and inventor of many devices in radio and cable telegraphy, died recently of a heart attack.

Born in Kiev, Russia, in 1876, Dr. Cohen was brought to this country as a boy. He studied at the Armour Institute of Technology in Chicago, receiving the B.Sc. degree in 1901, and subsequently attended the University of Chicago and Columbia University, the latter of which conferred the doctor's degree on him in 1905. That year he joined the staff of the U. S. Bureau of Standards and remained there until 1909 when he joined the Electrical Signaling Co., leaving four years later to open his own consulting practice. From 1916 on he also taught at George Washington University.

Over the years Dr. Cohen became internationally known for his researches into radio and telegraphy. During the first World War he developed for the Navy an instrument that became known as the Cohen receiver. From 1920 to 1924 he acted as consulting engineer for the War Department. Later he served on several international communications commissions, and wrote technical books and papers in the general field of electricity.

While practicing privately as a consulting engineer, he accepted many public assignments. In 1921 he was a United States delegate to the International Conference on Electrical Communications in Paris. Later he served on an advisory board at the Washington Conference on Limitation of Armaments. From 1929 to 1931 he was a technical expert with the German-Austrian Claim Commission.

Emanuel R. Piore (A'37–M'42–SM'43), director of the Physical Sciences Division of the Office of Naval Research, has been granted a year's leave of absence in order to do research work at the Massachusetts Institute of Technology's Electronics Research Laboratory.

An expert in electronics, composite surface physics, and color television, Dr. Piore received the Ph.D. degree in physics from the University of Wisconsin in 1936. After working as a physicist in the RCA Electronics Laboratory, he was placed in charge of the Columbia Broadcasting Co.'s Television Laboratories. From 1942 to 1946 he was a senior physicist for the Bureau of Ships, and served the Deputy Chief of Operations for Air as a specialist on guided missiles. Since 1946 Dr. Piore has directed the fundamental research program in the physical sciences sponsored by the Office of Naval Research.

◆

Walter F. Kean (S'41–A'43), who has headed the Broadcast Consulting Division of the Andrew Corp. since its formation in 1944, has becomes sales manager of the same company. Prior to joining Andrew, he was with the Western Electric Co. in Chicago.

◆

George F. Callahan (A'39) has been appointed division engineer of cathode-ray tubes in the General Electric Co.'s tube division. There he will assume the responsibility for all design and application engineering and standardizing activities relating to cathode-ray-tube product lines.

A native of Elk Point, S. D., Mr. Callahan was graduated from the University of Nebraska with the B.S. degree in electrical engineering. Since 1924, he has been engaged in the design, development, and manufacture of lamps and electronic tubes. Joining the Ken-Rad Tube and Lamp Corp. at Owensboro, Ky., in 1939, he worked on the design of receiving tubes and served for four years as the works manager of that company's Bowling Green plant. When General Electric acquired Ken-Rad, it acquired Mr. Callahan along with it. Since that time he has been active in the development of new miniature and cathode-ray receiving tubes.

◆

William Roth Work (A'42), Assistant Director of the Carnegie Institute of Technology's College of Engineering and Science, and one of the school's first faculty members, died recently.

Dr. Work, who had been affiliated with Carnegie since 1905, was born in Steelton, Pa., on May 4, 1881. After attending Wittenberg Academy in Springfield, Ohio, he received the A.B. degree from Wittenberg College in 1902, and the Master of Engineering degree from Ohio State in 1905. Wittenberg awarded him the honorary degree of Doctor of Science in 1920.

Associated with the Westinghouse Electric Corp. from 1905 to 1906, Dr. Work simultaneously served as a part-time instructor of mathematics at Carnegie. In 1906 he was appointed an instructor in electrical engineering on the CIT faculty, and three years later he was named an assistant professor. While holding an associate professorship at Carnegie from 1915 to 1920, Dr. Work was also a member of the Committee on Education and Special Training of the War Department General Staff during World War I. Subsequently he served as veterans' adviser for the school.

Vitally interested in scientific progress, Dr. Work was a Fellow of the AIEE, and a member of the American Society for Engineering Education, the Engineers' Society of Western Pennsylvania, and the American Association of University Professors, as well as belonging to a number of honorary fraternities.

Arnold Everett Bowen (SM'46), research engineer who contributed significantly to the development of radar, died recently following a brief illness.

Mr. Bowen was born on October 21, 1900, in Lowell, Mass. Educated at the Sheffield Scientific School, Yale University, he received the Ph.B. degree, summa cum laude, in 1921. Later he attended the Yale Graduate School, where he served as an assistant in the Department of Physics. In 1923 he joined the Development and Research Department of the American Telephone and Telegraph Co., and, with the entire department, transferred to Bell Laboratories in 1934, remaining with them until his death.

Mr. Bowen did much of the pioneer work in developing a system for transmitting microwaves through hollow guides. This technique made possible new forms of radar, which were used extensively in World War II. His research work and his inventions also furthered the development of microwave devices now used in radio, telephone, and television transmission.

In 1942 Mr. Bowen was commissioned as a major in the Army and worked first on antisubmarine equipment. For a short while he was stationed in Trinidad, and later served as a consultant at Langley Field. He then returned to Bell Laboratories, but was commissioned again, and, as a lieutenant-colonel, served in Washington as officer-in-charge of the Air Forces' Airborne Radar Equipment Board.

Mr. Bowen was a member of the American Physical Society and of Sigma Xi, national science honorary fraternity. Currently he was serving on the IRE Board of Editors.

◆

Philips B. Patton (A'46) has joined the Lenkurt Electric Co. in San Carlos, Calif., as a field engineer in the carrier division.

A native of California, Mr. Patton attended the University of Maryland and San Francisco State College. He began his communications career with the Western Union Telegraph Co. in 1931. After eleven years, he joined Pan American Airways as flight radio officer. In 1942 he became associated with the Federal Communications Commission, serving for the next two years and again from 1945 to 1946. In the intermediary period he returned to Pan American.

While with the FCC, Mr. Patton served with the Board of War Communications on telegraph and telephone operations, the San Francisco field office of the common-carrier division, and in 1946 was appointed acting chief of the radiotelephone and telegraph section of the division's engineering department. Subsequently he joined the Farnsworth Corp. as technical co-ordinator for the Fort Wayne, Ind., division.

G. E. Van Spankernen

Chairman, Buenos Aires Section

Gerardo Evan van Spankernen was born in Amsterdam, Holland, in 1907, and was educated in that country, receiving his degree as an electrical engineer in 1929. Immediately after his graduation he joined the Philips Co. in Eindhoven, Holland, starting as an assistant in the engineering laboratory, where he worked on electronic measuring instruments. From 1932 until 1933 he was stationed with the Philips Co.'s British Division in London and with their French division in Paris, where he installed electrical measuring equipment and acted as an instructor to explain its usage.

In 1933 he was assigned to the engineering laboratory to develop special radio receivers designed for Swiss usage. Upon completing their development, he was sent to Le Chaux de Fonds in Switzerland to help install the Philips factory there for manufacturing the receivers. Returning to Holland at the end of the year, he was appointed to do a similar job for Philips in Buenos Aires, Argentina.

The beginning of 1934 found Mr. van Spankernen in Argentina, starting the Philips Co.'s new factory there. Until 1938 he took charge of the entire development and manufacture of radio receivers, but, as the plant grew, he found that the engineering laboratory demanded the whole of his attention. After that, as chief engineer, he headed the laboratory which develops radio receivers and transmitters and also includes a chemistry laboratory to test materials and develop manufacturing procedures.

From 1938 on Mr. van Spankernen made a series of short trips to Europe and the United States in order to familiarize himself with the latest developments and procedures. In 1947 he was given the title of "Gerente Tecnico," which is technical manager with power of attorney.

Mr. van Spankernen became an Associate Member of the Institute in 1939 and a Senior Member in 1945.

K. R. Patrick

Chairman, Montreal Section

K. R. Patrick was born in St. John, New Brunswick, in 1915, and received his early education there. When his family moved to New Haven, Conn., he continued his studies there, afterward attending various colleges.

Immediately after graduating from school Mr. Patrick formed and operated an industrial sound company of his own in Massachusetts, returning to Canada when war broke out. He was commissioned a Flying Officer in the RCAF, serving until his discharge in October, 1945, with the rank of Wing Commander. During the war he served as Commanding Officer of the Canadian Air Force's Number One Wireless School in Montreal, and also was in command of the Number Five Radar and Communications Station, the joint Canadian-American-British development and training organization at Clinton, Ont. He received the O.B.E. for his work in radar in 1943, and in 1945 the American Government presented him with the Legion of Merit in recognition of his services in the research and development of guided missiles.

Since the war Mr. Patrick has been connected with the RCA Victor Co., Ltd., of Canada, of which he now manages the engineering products division. In 1947 he was appointed industrial member of the Electronics Advisory Committee of the Defense Research Board and this spring was re-appointed for an additional three years. He is also a member of the executive committee of the National United Services Institute. Becoming a Member of the IRE in 1943, Mr. Patrick was advanced to Senior Membership later that same year. He is a member of the Electronics Advisory Committee for the Ontario Government School of Electronics, the Board of Governors of Sir George Williams College in Montreal, and the Society for the Promotion of Engineering Education.

JTAC Requests Technical Co-operation in Connection with FCC Television Hearings

The JTAC (Joint Technical Advisory Committee) was formed jointly by The Institute of Radio Engineers and the Radio Manufacturers Association in May, 1948, for the purpose of "rendering additional public service in their fields of activities."

The JTAC objectives are quoted below from the Charter:

"To obtain and evaluate information of a technical or engineering nature relating to the radio art for the purpose of advising Government bodies and other professional and industrial groups. In obtaining and evaluating such information, the JTAC shall maintain an objective point of view. It is recognized that the advice given may involve integrated professional judgments on many interrelated factors, including economic forces and public policy."

The duties of the JTAC are:

"To consult with Government bodies and with other professional and industrial groups to determine what technical information is required to insure the wise use and regulation of radio facilities.

"To establish a program of activity and determine priority among the problems selected by it or presented to it in view of the needs of the profession and the public.

"To sift and evaluate information thus obtained so as to resolve conflicts of fact, to separate matters of fact from matters of opinion, and to relate the detailed findings to the broad problems presented to it.

"To present its findings in a clear and understandable manner to the agencies originally requesting the assistance of the Committee.

"To make its finding available to the profession and the public.

"To appear as necessary before Government or other parties to interpret the findings of the Committee in the light of other information presented."

The first task assumed by JTAC was at the request of the Federal Communications Commission, and was to assist the FCC in its deliberations concerning the future use of frequencies from 475 to 890 Mc for television broadcasting.

With the assistance of IRE and RMA Technical Committees and others, a preliminary study was made and a report was presented to the FCC at the hearing, docket 8976, held on September 20, 1948. As a result of this hearing and in order to arrive at a decision, the FCC has called an engineering conference to be held on November 30, December 1 and 2, 1948. In the correspondence which is reproduced on the following pages, Chairman Wayne Coy of the Commission has asked the JTAC to make preliminary studies in preparation for this conference.

It will be observed that the date of this conference anticipates the date of publication of this issue of the PROCEEDINGS. Members are advised, however, that this promises to be a continuing study and that all pertinent additional information will be of value beyond the established deadline. **It is urged, therefore, that the membership of the Institute co-operate in supplying the Secretary of the JTAC, L. G. Cumming, at the Institute Headquarters, 1 East 79 Street, New York 21, N. Y., with all available data. The attention of all Technical Committees is invited to the importance of the contributions to the preliminary report made by the IRE and RMA Technical Committees.**

Following presentation of the September 20, 1948, report, the chairman of the JTAC offered the further services of the committee to the chairman of FCC. The following reply is reproduced as received:

FEDERAL COMMUNICATIONS
COMMISSION
WASHINGTON 25, D. C.

October 28, 1948

Mr. Philip F. Siling, Chairman
The Joint Technical Advisory Committee,
IRE-RMA
1 East 79th Street
New York 21, New York

Dear Mr. Siling:

I have your letter of October 1, 1948, offering the continued assistance of the JTAC in providing information which will be helpful to the Commission. I quite agree that the major tasks which JTAC undertakes for the Commission should be in response to requests through the Commission rather than through staff contacts. In this way we can assure that emphasis is placed upon the problems which the Commission considers to be the more important.

While the question of JTAC assistance may appear to have lain dormant since the September 20th hearing, I assure you that such is not the case. Your participation in the current proceedings relative to very-high-frequency and ultra-high-frequency television has been one of the principal topics for discussion in the several Commission and staff meetings which we have held on these subjects since that date. I have deferred answering your letter, however, until our plans for proceeding in the television matters had crystallized and a definite proposal could be made.

The more urgent of the two proceedings is of course the one regarding very-high-frequency, involving as it does a freezing of assignments for an indefinite, but we hope a limited, period. It would appear, therefore, that any activity in regard to the ultra-high-frequency situation which will result in a delay in the very-high-frequency considerations should be postponed until a later date.

Although the time is short and it is appreciated that only a small amount of new information can be developed within its limitations, nevertheless, it should be sufficient for collecting and processing certain pertinent information which has been accumulating since the last major revision of the standards.

I am forwarding herewith a copy of FCC 48-2256, "Notice of Further Proposed Rule Making" in Dockets 8975, 8976, and 9175, outlining the procedure to be followed for VHF television. There is also enclosed a copy of FCC 48-1966, the notice of issuance of four reports in preparation for the engineering conferences which are part of the procedure.

Ten additional copies of the notices and ten copies of each of the reports are being sent under separate cover for use by JTAC. Copies of the channel studies, referred to in paragraph IVB of FCC 48-2256, will be forwarded when issued.

A reading of the procedure outlined in FCC 48-2256 will indicate that the agenda for the engineering conferences is a rather heavy one, although it is being limited to factors which have an appreciable effect on the station allocation plan. A considerable preparation will be involved, both by the Commission and by the Industry.

While the Commission will be able to make contributions in some degree to a substantial number of the items listed in the agenda, personnel who will be available for this proceeding will devote their time principally to the following:

1. Further study of tropospheric effects, particularly the effect of transmitting antenna heights, Item IVD(1) (a).
2. Further study of terrain effects, IVD (2).
3. TV and FM channel studies, IVB.
4. Preparation of a film showing the effects on the received picture of various signal/noise ratios and desired/undesired ratios of co-channel and adjacent-channel interference, affecting items IVE(3) and (4).

It is not desired to circumscribe the activities of JTAC in its efforts to assist the Commission in this proceeding, but I would recommend that the following matters be given particular attention, the procedure indicated in each case, of course, being merely by way of suggestion.

1. That JTAC submit the accompanying reports to the proper committees of the IRE and the RMA for comment, recommending that any similar studies which are known or can be prepared by persons on the committees be made available for consideration at the first conference.
2. That JTAC and the committees of the IRE and the RMA study the agenda announced in FCC 48-2256 critically with a view to (a) detecting any omissions or any items which are believed to be unnecessary to a resolution of the channel allocation problems, (b) determining the items upon which information can be furnished by JTAC and its associated committees and (c) assessing the adequacy of the time schedule in permitting the formulation of answers to the various items.

Some of the items on which the JTAC

and its committees can be of particular assistance are the following:

IVD(3) Antennas. In addition to transmitting antennas and the practicability of assuming directional operation in the allocation plan, practical receiving antennas and their directional effects should be considered.

IVE(3) Re-examination of co-channel and adjacent-channel ratios, on the basis of test data to be furnished by the manufacturers of various commercial receivers.

IVE(4) Re-examination of contours involving:

a. Noise and interference levels in urban and suburban areas at various frequencies.
b. Noise figures for commercial receivers.
c. Acceptable signal/noise ratios.
d. Typical receiving antennas and transmission lines.

IVE(6) & (7) Present capabilities of power generation for frequencies between 54 and 216 megacycles.

The JTAC may desire to furnish answers to items other than those which I have listed and should, of course, feel perfectly free to do so. Complete or partial answers to some of the items may be found in previous information furnished by JTAC, in which case the reply should so indicate, with appropriate references.

Do not hesitate to call upon the Commission if further details or clarification of our request is desired.

Sincerely yours,
Wayne Coy,
Chairman

Enclosures

The FCC Notice 48-2256 referred to above is here reproduced:

Received October 18, 1948
FCC 48-2256
27297

FEDERAL COMMUNICATIONS
COMMISSION
Washington, D. C.

In the Matter of Amendment of Section 3.606 of the Commission's Rules and Regulations	Docket Nos. 8975 and 8736
In the Matter of Amendment of the Commission's Rules, Regulations and Standards concerning the Television and Frequency Modulation Broadcasting Services.	Docket No. 9175

Notice of Further
Proposed Rule Making

I. Notice is hereby given of further proposed rule making in the above-entitled matter.

II. During the hearing held by the Commission in the above-entitled proceeding (Docket Nos. 8975 and 8736) to consider proposed revisions of the Commission's table of television channel allocations, evidence was presented concerning (A) tropospheric interference to existing and proposed television stations, (B) the use of directional antennas, (C) the use of increased power, and (D) conflicting proposals for closer spacing and wider spacing between television stations than is presently provided for by the Commission. In order to assure that the Commission's national television allocation plan should be based on the soundest engineering foundation, an Industry-Commission Conference was held on September 13 and 14, 1948. The issues for decision at the Conference were:

"1. Whether the Commission should initiate proceedings to revise the television allocation rules and standards prior to final decision in Dockets 8975 and 8736.
2. If the standards are to be revised, what policy should be adopted with respect to applications now pending before the Commission.
3. What procedures should be adopted in order that the revised standards can be based on the best available engineering information."

III. At the conclusion of said Conference it was announced that the Commission would call an engineering conference to consider questions regarding revisions of the Commission's Rules, Regulations and Standards with respect to the technical phases of television allocations. This Notice deals with issues "1" and "3" set forth above. On September 30, 1948, the Commission issued its Report and Order herein concerning issue number "2." Further, since the Frequency Modulation Broadcasting Service is directly affected by any action taken with respect to propagation in the VHF band, revisions of the Rules, Regulations and Standards of that service is made a part of this proceeding.

IV. In order to facilitate and expedite the promulgation of rules, regulations and standards herein, the following schedule will be followed:

(A) On or about October 20, 1948, the Commission will make public:

(1) A report containing (a) a summary of available measurements of tropospheric fields, (b) empirical method of treating measurements to formulate field intensity vs distance curves for various frequencies for various percentages of the time and (c) representative tropospheric field intensity curves for antenna heights of 500 feet and 30 feet for various frequencies and percentages of time derived by the foregoing method.
(2) A study of the effects on service of the simultaneous fading of both the desired and undesired fields from tropospheric causes.
(3) A report on measurements made at Princeton, Southampton and Laurel on frequencies of 47.1, 106.5 and 700 Mc. radiated from transmitters in New York City.
(4) A study of the effects of terrain upon average signal levels as compared to smooth earth values and upon the variability of signal levels within limited areas.

(B) On or about November 15, 1948, the Commission will make public:

(1) A TV channel study showing the effects of ground wave and tropospheric interference on representative service areas of stations allocated in accordance with the Commission's Notice herein of May 5, 1948, as amended in the Commission's Supplemental Notice of July 15, 1948.
(2) A TV channel study in a representative area showing the effects of ground wave and tropospheric interference on the service areas of presently operating stations and CP's, but with other allocations spaced so as to protect the 500 u/m contours 90% of the time. (All allocations to be based on 50 kw/500 ft. in the center of the principal city).
(3) Channel study for FM showing the effects of ground wave and of tropospheric interference for 1% and 10% of the time on representative channels.

(C) On or about November 30, 1948, December 1, 1948 and December 2, 1948, the Commission will hold a series of engineering conferences in Washington, D. C.[1] All interested persons are invited to attend said conferences, participate fully therein, and to submit written data, views, or arguments with respect thereto. To assist the Commission in the expeditious conduct of said conferences, it is requested that persons who plan to participate therein file (by letter) notice of their intention to do so at least one week prior to the date of commencement of said conferences. Written statements may be filed on or before the dates of the respective conferences.

(D) The first conference to be held on or about November 30, 1948, will be on VHF propagation standards to arrive at standard methods of evaluating the effects upon propagation of the following factors:

(1) Tropospheric effects—
    (a) Variations with time in the field intensities to be expected at various distances from the transmitter, as functions of transmitting antenna height and of frequency.
    (b) Range of diurnal variations.
    (c) Range of seasonal variations.
    (d) Effects on service of the simultaneous fading of both the desired and undesired signals.
(2) Terrain effects—
    (a) Shadows—relation of the average field intensity in a limited area or limited section of a radial to calculated values as a function of the profile between the area and the transmitter.
    (b) Urban field intensities—validity of the FCC standards on Ground Wave Signal Range charts for predicting near-in fields in city areas.
    (c) Local terrain effects—variability of field intensities as compared to the average over a limited area or distance.
    (d) Receiving antenna height-gain factor–validity of assuming a

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[1] The exact date and place of each conference will be announced at a later date.

uniform variation of field intensity with receiving antenna height for relating mobile measurements made at low antenna height to the standard receiving antenna height of 30 feet. Consideration of the alternative method of spot measurements at 30 feet height.

(e) Apparent transmitting antenna height—validity of the 2–10 mile rule for estimating the apparent height of the transmitting antenna.

(f) Validity of the method presently prescribed in the Commission's Standards for equalizing coverage obtained by transmitters of varying antenna heights and power.

(3) Antennas—

(a) Practical limitations on vertical and horizontal directivity of transmitting antennas.

(b) Methods for establishing and maintaining the performance of directional antennas.

(c) The engineering basis for utilizing horizontal directivity in allocation problems.

(E) The second conference to be held on or about December 1, 1948, will consider the following items with respect to VHF television broadcasting:

(1) Tropospheric effects:

(a) Specification of grade or grades of service resulting from variations in the intensities of desired and undesired fields.

(b) Discussions of the effects of the specification of various grades of service on particular channel allocation plans.

(c) The development of standard tropospheric curves for various frequencies and antenna heights, calculated in accordance with methods approved at the propagation conference.

(2) Examination of current standards for the prediction of service areas to determine whether any modifications are dictated by the terrain effects considered in the propagation conference.

(3) Re-examination of co-channel and adjacent channel ratios at the receiver terminals in the light of more recent information; and a determination whether a terrain factor should be included in the field intensity ratios.

(4) Re-examination of the contours specified for protection and for recognized service levels at various frequencies.

(5) Re-examination of assumptions as to typical receiving antenna heights for urban and rural areas and of methods of proving station performance by measurement of received fields at such heights.

(6) Examination of the effects of horizontal increases in power upon protected contours in the channel allocation plans.

(7) Examination of the effects of differential increases in power on the protected contours and on the allocation plans.

(8) Examination of the effects of directional antennas on allocation plans.

(F) The third conference to be held on or about December 2, 1948, will consider the following items with respect to FM broadcasting:

(1) Tropospheric effects:

(a) Specification of grade or grades of service resulting from variations in the intensities of desired and undesired fields.

(b) Study of the areas provided with various grades of service under the present channel assignments and under the tentative allocation plan.

(c) The development of standard tropospheric curves for various antenna heights, calculated in accordance with methods approved at the propagation conference.

(2) Examination of current standards for the prediction of service areas to determine whether any modifications are dictated by the terrain effects considered in the propagation conference.

(3) Re-examination of assumptions as to typical receiving antenna heights for urban and rural areas and of methods of proving station performance by measurement of received fields at such heights.

V. Authority to issue amendments of the Commission's Rules, Regulations and Standards with respect to the matters to be discussed at the conferences listed above is vested in the Commission by Sections 301, 303(b), (c), (d), (f), (h) and (r), and 4(i) of the Communications Act of 1934, as amended.

VI. In accordance with the provisions of Section 1.764 of the Commission's Rules and Regulations, an original and 14 copies of all written data, views, or arguments filed shall be furnished the Commission.

FEDERAL COMMUNICATIONS
COMMISSION

T. J. Slowie, *Secretary*

Adopted: October 14, 1948
Released: October 15, 1948

THE JOINT TECHNICAL
ADVISORY COMMITTEE

THE INSTITUTE OF RADIO
ENGINEERS, INC.
RADIO MANUFACTURERS ASSOCIATION

Pursuant to this letter, the chairman of JTAC addressed the following letter to the chairmen of all Technical Committees and other interested groups:

October 29, 1948

Dear Sir:

As you doubtless know, the FCC has scheduled tentatively a three-day engineering conference for November 30, December 1 and 2. The schedule for this engineering conference is included in the attached FCC release and requests information on propagation and allied subjects in the vhf portion of the spectrum, particularly as it affects standards and allocation problems of the television and FM services.

The Commission, through the letter copy attached, has requested the JTAC to assist in the collection of information for this conference. Accordingly, JTAC is requesting the assistance of engineering groups within the RMA and IRE, as well as other industry groups. As Chairman of one of these groups, we urgently request that you read carefully the attached material from the FCC.

The JTAC will greatly appreciate any information, engineering data, and comments regarding these subjects that you may be able to submit by November fifteenth to the Office of the Secretary.

Sincerely,

PHILIP F. SILING

Enclosures 2

* * *

Electronics in Nuclear Physics*

W. E. SHOUPP†

The publication in the PROCEEDINGS OF THE I.R.E. of a series of papers on nuclear particles and phenomena, and on electronic instrumentation and control of nuclear processes, continues through the presentation of the following paper. This paper clearly sets forth certain fundamental nucleonic facts, their relationship to electronics, and some of the many and intriguing opportunities offered to the electronics expert who enters the nuclear field.—*The Editor.*

INTRODUCTION

IN AN EFFORT to determine where the science of electronics crosses the path of nucleonics and just what are the results when they meet, it will be necessary to define reasonably well the two words "electronics" and "nucleonics." The word "electronics" requires little discussion here; however, it may be interesting to try to put a definition into words.

Generally speaking, electronics embraces all phenomena associated with the passage of electric currents through gases and high vacua.[1] Such phenomena may be utilized for many purposes, such as the generation, amplification, and detection of high-frequency electrical oscillations, and the production of light from electric current, as well as the converse process. The propagation processes and the study of interstellar radiations are likewise included. Studies concerning the acceleration, generation, and use of atomic particles and radiations may also be included in electronics.

Electronics may then be defined as that science, art, and industry concerned with electrical phenomena involving electrically charged atomic particles outside of liquids and solids. Under this definition we have included phenomena other than those due to the action of electrons.

Now, if we define nucleonics, we may see where the two fields fit together or possibly overlap, and it may be possible to draw some conclusions as to their interaction. The nucleus is supposed to be made up of particles called "nucleons." Until recently it was supposed that protons and neutrons in combination make up all nuclei. In line with recent meson theory, this does not necessarily follow; however, the term nucleon will usually refer to a nuclear proton or neutron. Nucleonics, then, is the science dealing with the rearrangement, transformation, and utilization of the nucleons. This includes nuclear synthesis, radioactivity, nuclear fission, and their applications. We will not expect interactions between electromagnetic waves of the microwave and radio spectrum and the fundamental nuclear particles and radiations because of the vast difference in wavelength. Electronics will, therefore, be of chief importance in observing the physical processes that occur in ordinary and induced nuclear phenomena. In fact, if electronics is to influence nucleonics, it must be in the course of the discovery, production, measurement, control, use, or disposal of nuclear substances. The better to see just how this may come about, a brief discussion of some of the general properties of nuclei is necessary.

Most radioactive substances that are generally available are generated in the nuclear reactor commonly called a "pile." After looking into the operation principles of the pile, the characteristics of its radiations, and its radioactive products, it will be possible to point out where electronics may contribute to the technology of nuclear processes through the fabrication and location of the proper materials for pile construction, the control of the pile during operation, or the utilization of the products manufactured within the pile.

THE URANIUM PILE OR NUCLEAR REACTOR

The active ingredient of the pile is uranium, usually in the metallic form. The largest known deposit was discovered in Northern Canada, where it is found to exist in the form of the uranium-oxide complex $U(UO_4)_2$. Already we have met electronics head-on, because our modern uranium prospector who made the discovery used a Geiger-counter radiation detector to find the ore, which is a radioactive material. The detector used here is not so complex as some other electronic equipment, but is a model of compactness, reliability, and clever electronic engineering. Detectors of this type have been made that weigh less than four pounds and are sometimes powered by four flashlight cells.

The uranium oxide, after being discovered and mined, is reduced to pure metallic uranium and is found to have a specific gravity of 18.7, an atomic weight of 238.07, and a melting point of 1150°C. It is also known that 99.3 per cent of the metallic material is composed of the heavy isotope ${}_{92}U^{238}$ and 0.7 per cent is ${}_{92}U^{235}$. Suppose, now, that after considerable mining and chemical reduction we have accumulated sufficient uranium metal to set up a self-sustaining fission reaction in an assembly called a nuclear reactor or pile.

The essential thing about the process of uranium fission is that the uranium atom falls apart in such a way as to produce two more or less equal fragments—and to liberate several more free neutrons. It is this neu-

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* Decimal classification: 621.375×539.7. Original manuscript received by the Institute, August 26, 1948.

† Westinghouse Research Laboratories, East Pittsburgh, Pa.

[1] E. U. Condon, *Bull. Nat. Electronics Con.*; 1946.

tron liberation that makes a self-maintaining process possible. The splitting requires a neutron to make it go; the splitting process itself acts as a source of neutrons which can cause more uranium atoms to split. Here is the basis for a chain reaction.[2]

Why, then, does not ordinary uranium explode, or at least "burn," in a nuclear sense? Since several neutrons are released at every fission, a chain reaction is possible. But one of the several neutrons released must actually produce another fission to keep the process going.

If all the neutrons released produced more fissions, the material would explode violently. Since the neutrons move rather freely through matter (like X rays) many are lost by escaping through the surface. Consequently, it is necessary to use a big enough lump of fissionable material to get a smaller surface-to-volume ratio. In other words, unless the lump exceeds a certain critical size, the chain reaction cannot proceed.

Another complication is that impurities in the uranium have a powerful effect on the neutron loss through absorption. This loss of neutrons is very difficult to obviate, for appreciable losses result from the presence of only one part per million of some materials, and it is no easy matter to produce anything of that purity on an industrial scale.

The worst complication of all is that uranium itself absorbs neutrons in other ways than those that produce fission. This phenomenon is both a blessing and a curse. It turns out, fortunately, that the over-all effect of this nonfission absorption of neutrons by uranium is sufficiently great to prevent the explosion of perfectly pure uranium, in normal isotopic abundance, even in so large a lump that escape of neutrons through the surface is negligible.

Neutrons given out in the fission process are "fast"; that is, they possess speeds corresponding to several million electron volts of kinetic energy. Such fast neutrons colliding with uranium atoms have a rather great chance of losing energy without being caught and without producing fission. On the other hand, neutrons of intermediate speed are unable to produce fission in U^{238}. They can do so only in U^{235}, which forms only 1/140 part of natural uranium.

Neutrons of a particularly low energy (about 10 electron volts) are very like to be captured by U^{238} to form U^{239}. This is very important! In fact, this happens so readily that so many neutrons are used up in this process that a chain reaction cannot be maintained in ordinary uranium alone.

An uncaptured neutron continually loses energy by colliding with atoms as it diffuses throughout any material, until its average energy is that of the heat motion of the atoms of the material. Neutrons of certain extremely low energies are strongly captured by U^{235} to produce fission.

To cause and maintain a chain reaction with ordinary pure metallic uranium, which contains all kinds of uranium atoms but is predominantly U^{238}, the uranium is arranged in a lattice of small lumps so that many of the fast-moving neutrons diffuse out of the uranium into some surrounding material. Here many of them are slowed down before diffusing back into the uranium. Most neutrons thus escape being caught by U^{238} until they have lost so much energy that capture by U^{238} is unlikely. Ultimately, unless the neutrons are lost in the surrounding medium, they return to the uranium lumps and are sufficiently reduced in speed to cause fission in U^{235}, but have energies too low to be captured by U^{238}.

In the technical vocabulary of nuclear engineering, the material that temporarily traps the neutrons and helps them lose energy until they are safe from capture by U^{238} is called the "moderator." Evidently the moderator material must not absorb too many neutrons itself, or the reaction will be stopped. Besides not absorbing neutrons, a desirable moderator has a low atomic weight. For, to be slowed most efficiently, the neutrons are allowed to collide elastically with the nuclei of the moderator material. More energy is given up at each impact if the two partners of the collision have nearly the same mass.

The hydrogen content of ordinary water (H_2O) would be ideal with respect to mass, but ordinary hydrogen absorbs too many neutrons. Heavy water (D_2O) is satisfactory from a neutron-absorption standpoint, but is not generally available in sufficient quantity. Metallic beryllium is a possibility, but is quite expensive. Therefore, specially purified graphite was finally adopted in the original piles constructed. In a typical graphite-moderated pile a neutron that has escaped from the uranium into the graphite travels roughly about 1 inch between collisions and makes, on an average, 200 elastic collisions before returning to the uranium, losing about $\frac{1}{6}$ of its energy in each collision.

A chain reaction is then possible, but since the nuclear fission process takes place in very short time and with considerable evolution of energy, how can the pile be kept from blowing up? If a pile is so arranged that, on the average, more than one fission results from the neutrons produced by each fission, then clearly the number of neutrons present, and the amount of heat generated, increase by the compound-interest law. If a great multiplication happens rapidly—say, in a small fraction of a second—then the phenomenon becomes an explosion. In short, we have an atomic bomb. Even if the reaction occurs slowly, the pile would soon be destroyed by melting if the multiplication were allowed to proceed.

One way to control the pile[3] is to provide passageways through it into which rods of material that strongly absorb neutrons can be placed. When these rods are all the way in, they absorb so many neutrons that the chain reaction is stopped. As they are slowly withdrawn, a point is reached at which the reaction is just able to proceed. If pulled out farther, the neutrons are able to multiply more rapidly and the pile operates at a higher power level. To stop the pile the absorbing rods are simply pushed back in farther. Cadmium and boron-containing steel are suitable materials for the control rods.

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[2] E. U. Condon, *Westinghouse Eng.*, vol. 5, pp. 3, 9; November, 1945.

[3] H. D. Smyth, "Atomic Energy," Princeton University Press, 1945; p. 135.

We have so far assumed that the build-up time for the chain reaction used in the pile is long enough for an operator to maintain control by manual operation of the rods or by use of a similar slow-acting control mechanism. That is in fact the case, due to another fortunate phenomenon in the fundamental physics of fission—delayed neutrons.

It was discovered in May, 1942, that not all neutrons emitted in the fission process come out instantly. The uranium nuclei in splitting apart spill out most neutrons immediately. But the atomic fragments formed are also in a highly unstable condition and some of them throw out additional neutrons after a short time delay, amounting on the average to half a minute. It is the delayed ones that set the time scale on which the neutron multiplication in the pile builds up. They set it for such a long time that slow-acting controls are easily able to regulate the activity of the pile. In fact, 1 per cent of the neutrons are delayed by at least 0.01 second and 0.07 per cent are delayed by as much as a minute.[3]

Here is an ideal chance for electronics to contribute. The delayed neutrons do provide a bit of time to activate controls, but sensing and control-activating methods are necessary. It is presumably possible to measure the temperature within a pile by appropriate sensing elements such as bolometers or thermocouples, and to use the temperature level so measured properly to position the control rods. It would also seem feasible to measure the neutron intensity at some arbitrary point, and to use the signal thus obtained to operate the controls. In any event, electronic controls for the drive motors operating the control rods seems to be indicated. This is particularly true since operations of this sort probably require antihunting methods and accurate control.

Since a nuclear reactor is a very valuable and expensive machine, it is likewise important that elaborate precautions be taken against operating the pile at such a high level that internal damage to the reactor might occur. Here, again, electronics has an ideal application. More or less standard methods are indicated for this job.

There is, however, one missing link. How do we measure the level of neutron intensity so as to operate our controls and precautionary devices? We have seen that neutrons are nonionizing particles and for that reason we cannot use exactly the same techniques that we apply to β rays, α particles, and the like. What is done is to cause the neutrons to produce an ionizing particle (usually an α particle) and to infer the neutron intensity by counting the number of particles produced. One of the best ways of doing this is to allow the neutron flux to fall upon a chamber, filled with boron-trifluoride gas (BF_3) and surrounded by considerable hydrogeneous material, usually about 10-cm thickness of paraffin. The neutrons entering the paraffin will be slowed down by making elastic collisions with the hydrogen in the paraffin and then will become very active in causing the following nuclear reaction to occur:

$$ {}_5B^{10} + {}_0n^1 \rightarrow {}_3Li^7 + {}_2He^4. \tag{1}$$

In this reaction an α particle (${}_2He^4$) of 2.7 Mev is emitted and will produce either a pulse in an ionization chamber or will trigger a Geiger or proportional counter. We have here a means for generating electric pulses from neutrons, but electronics must supply all the technology between the sensing element and the control activator. Various types of amplifiers and electronic circuitry are used for this service. It will be the task of succeeding papers by other authors in this series to describe this technology in detail. Suffice it to say that there is need for a vast array of fast and slow pulse amplifiers, dc amplifiers, coincidence circuits, discriminators, scaling circuits, and others too numerous to mention. Their use for this and similar applications forms one of the most interesting electronic fields of endeavor today.

Now let us return to the nuclear reactor and see what else is going on. The first pile was built on the University of Chicago campus during the fall of 1942. It contained 12,400 pounds of uranium together with a graphite moderator. It was intended to be spherical in shape, but since the critical dimensions proved to be smaller than the original calculations indicated, the sphere was left incomplete, giving the actual pile the shape of a large inverted doorknob.

It was first operated on December 2, 1942, at a power level of ½ watt, and on December 12 the power level was stepped up to 200 watts but the pile was not allowed to go higher because of inadequate provision for shielding the personnel. Further studies on piles were made by the construction of one in Tennessee designed for 1000-kw level of operation. Later a pile using heavy water instead of graphite as moderator was built.

It should be remembered that, although a pile is built with ordinary uranium, it is only the 0.7 per cent that represents active U^{235} metal. Most of the metal is U^{238} and actually tends to stop the process. Only by an ingenious lattice arrangement for slowing neutrons in a moderator is the pile able to operate in spite of the presence of the more prevalent U^{238}.

This means that, regarded as a fuel, only 1/140 of the total weight of uranium is being directly used; the rest is an inert material that remains largely untransformed by the pile.

How does the bomb chain reaction differ from that in the pile? The atomic bomb explodes, whereas the reaction in the pile proceeds at a slow rate, easily controlled by manual operation of absorbing rods. The big, fundamental distinction is that the bomb (one type) is made of essentially pure U^{235} and without the use of moderator. The chain reaction in the bomb is carried on by fast neutrons directly released by fission. As already remarked, this cannot happen with ordinary uranium; the U^{238} slows the neutrons to the point where they cannot produce fisssion in U^{235}. In addition, U^{238} absorbs many of them. With essentially pure U^{235} these competing absorption processes do not occur and the reaction is carried by the fast neutrons directly emitted from a U^{235} fission. These are utilized at once to produce fission in other U^{235} atoms. Here the main factors tending to stop the reaction are the loss of neutrons through the surface (which sets a minimum size to the bomb) and losses by absorption due to impurities, including any remaining U^{238}.

What is plutonium? This is a newly discovered chemical element not known to exist in nature, but which is made from uranium by atomic transmutation. Plutonium is important because it, like U^{235}, is a material from which atomic bombs can be made.

That U^{238} can capture neutrons has already been mentioned as a phenomenon detrimental to the operation of a pile. When U^{238} captures a neutron it becomes U^{239} and emits gamma radiation, as does radium. This U^{239} is not stable but emits high-speed electrons by a process of spontaneous radioactivity. The mean life of the U^{239} atoms is only about 20 minutes. By this activity they are transformed into atoms having essentially the same mass but one greater positive charge, 93, on the nucleus, and hence a new chemical element. It is called neptunium and written as Np^{239}. Neptunium 239 is also spontaneously radioactive and emits another high-speed electron, becoming thereby an atom having 94 positive charges on the nucleus but still essentially of mass 239. This process is slower; the mean life of the neptunium atoms is about two days. The resulting atom of charge 94 and mass 239 is another new element that does not occur in nature. It is called plutonium and is written Pu^{239}.

Actually, the purpose of piles in the military project was not to get atomic power but to produce the new element plutonium, which provides a second bomb material. It is, in short, a competitor to U^{235}. Since the uranium lumps in the pile are exposed to a dense atmosphere of neutrons, the means is at hand for changing a part of the U^{238} into Pu^{239}.

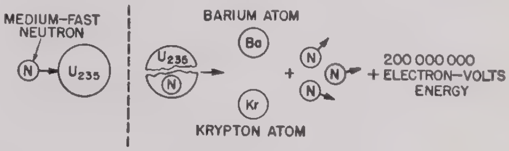
The several large piles thus put in operation generated many hundreds of thousands of kilowatts as heat. This heat was, however, not utilized, as the main purpose of the operation was production of plutonium for use in the atomic bomb. To utilize the heat efficiently it would have been necessary to operate the pile at high temperatures, requiring extensive modification of pile construction.

The pile, when run at a high power level, also generates an enormous amount of radioactive material, far more potent than all the radium ever mined. This greatly complicates the problem of operation of the large piles by requiring a high standard of reliable operation that must depend entirely on remote controls.

The plutonium is formed in the blocks of uranium in the pile. These have to be removed from the pile and the plutonium extracted by fairly simple chemical methods, because plutonium and uranium, being completely different elements, are dissimilar chemically. The process, however, is greatly complicated by the intense radioactivity of the materials.

RADIOACTIVE BYPRODUCTS OF THE PILE

In all this involved process, what has happened to the uranium atoms we were watching? We have seen that some of the U^{235} has been caused to fission. For example, the U^{235} nuclei have split into roughly two equal parts, as indicated in Fig. 1. We now have a barium and a krypton atom, and two or three neutrons have been emitted. The nuclei of the barium and krypton are very different from the ordinary types found in nature. In fact, in this special case the krypton formed is deficient by three positive nuclear charges, and the barium nucleus is deficient by four, from a stable condition. Consequently, these nuclei are radioactive and will emit β particles and γ rays until stability is attained. Barium and krypton and their intermediate decay products are not the only radioactive isotopes formed as a result of the fissioning. In fact, possibly a hundred different radioactive isotopes are produced in this process.



$${}_0n^1 + {}_{92}U^{235} \rightarrow {}_{36}Kr^{89} + {}_{56}Ba^{144} + 3\,{}_0n^1$$

Fig. 1—Typical neutron-induced fission of U^{235} atom.

Fission into precisely equal masses seldom occurs, the most abundant fragments being one of a mass number between 127 and 154 and the other between 83 and 115. The half-lives of the unstable isotopes thus formed vary from a small fraction of a second to over a year. Radiations from these radioactive elements present one of the major health problems to the personnel working in this field. The isotopes are, of course, chemically recoverable and are valuable byproducts from pile operation. In addition to the radioactive fission products, heavy nuclei, U^{239} and Np^{239}, are present in the pile. The concentration of these materials builds up within the pile during normal operation until eventually their decay is equal to their rate of formation; their concentration then becomes constant, thus presenting interesting limitations of the economics of pile operation.

Within the chain-reacting pile, a very high flux density of neutrons is maintained. If certain elements are inserted within the pile, intense radioactivity may be induced in most isotopes by neutron capture. As an example, radioactive phosphorus (P^{32}) is made by inserting ordinary phosphorus within a pile and inducing the following reaction:

$$P^{31} + n^1 \rightarrow P^{32} + \gamma \tag{2}$$

where the superscripts indicate the total number of protons and neutrons in the nucleus (mass number), and the letter is the symbol for the element or radiation involved. At the present time seventy-five radioactive isotopes made by this method may be obtained from the Atomic Energy Commission, and several hundred more may be made within piles or by bombardment by the beam of nuclear accelerators. These radioactive materials are useful for a vast variety of applications, a few of which will be mentioned. Radioactive sulphur may be used to determine the amount of sulphur remaining in coke; radioactive phosphorus may be used to analyze the phosphorus content of steel; while solid or liquid and other radioactive materials may be used to examine the finished steel for flaws or inclusions.

In medicine, clinical use in made of radioactive materials in the diagnosis and treatment of certain thyroid disorders. The motion of the blood, heart action, and digestive processes may also be investigated by means of radioactive techniques. In fact, radioactive tracers may be followed quantitatively throughout the various physical and chemical processes to which they may be subjected. All applications of these materials depend upon the detection and accurate measurement of the position and quantity of disintegrating radioactive nuclei. It is in this application that electronics finds its greatest possibilities. In fact, the real importance of analysis by radioactive isotopes lies in the fantastic sensitivity of the electronic detection methods that are applicable. Here we reach the ultimate in detection sensitivity, where individual exploding atoms are detected and accurately counted. This leads to applications where tremendous dilutions are encountered. Ionizing radiations are emitted by radioactive materials and the ions formed within gases, liquids, and solids may be used to indicate the presence of radioactive atoms. A vast variety of electronic devices is available for these applications, and a series of comprehensive articles written by well-known authorities on the various types of instruments will be published in succeeding issues.

NUCLEAR RADIATIONS FROM RADIOACTIVE MATERIALS

The radioactive material may emit β radiation (high-speed electrons), positrons (β_+), α particles (helium nuclei), γ radiation, neutrinos, and antineutrinos. The latter two are nonionizing particles of low mass, more or less hypothetical, and so far have not been directly observable. Nearly all of the detection methods for α, $\boldsymbol{\beta}$, β_+, and γ radiations are based upon the electrical response generated when these radiations cause primary and secondary ionization processes as they pass through matter. For α and β radiations, the ionization is produced in the slowing down of the particles themselves. On the other hand, γ radiations are detected by the ionization produced by the Compton recoil electrons, photoelectrons, and electron-positron pairs that are produced as they pass through matter. Since the electronics specialist plans to use ionization to indicate the presence of such radiation, it is of great importance that the energy, penetrating power, and ionization density of the radiation be known. In general, ordinary radioactive materials emit radiations having energies that vary from several kilovolts to a few million volts. When dealing with these radiations, it is convenient to remember the following rough characteristics of these radiations.

PROPERTIES OF ALPHA RADIATION

The range of α particles in air at ntp (normal temperature and pressure) is about 1 cm for 2 Mev, 2 cm for 3.4 Mev, and 5 cm for 6.3 Mev. On the average the energy loss is about 1 Mev per cm of air forming about 40,000 ion pairs. A better insight into the ionization by α radiation may be obtained from examining Fig. 2, which shows the specific ionization along the path of the particle. Similarly, Fig. 3 shows the range of α particles in air at ntp.

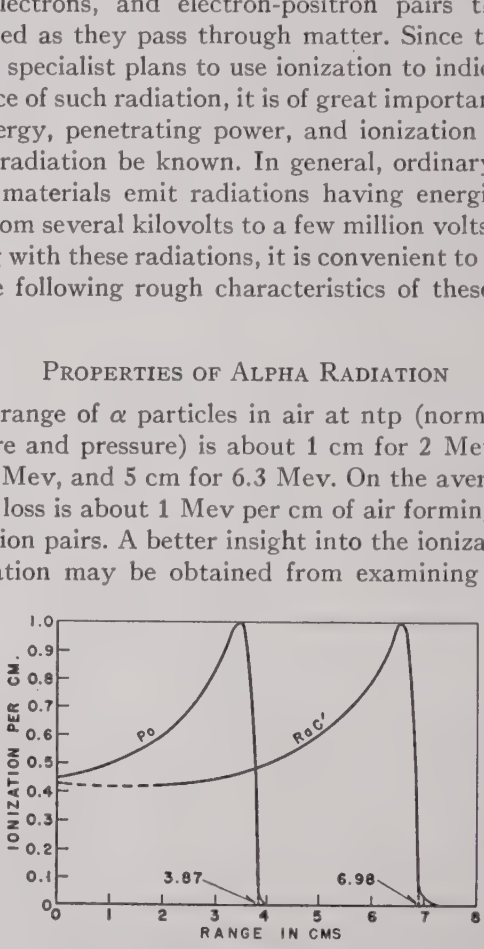


Fig. 2—Relative specific ionization of α particles from polonium and radium C'.

PROPERTIES OF ELECTRONS (β) AND POSITRONS (β_+)

Electrons and positrons (β and β_+ particles) have a mass that is only 1/1838 that of the α particle and are scattered considerably as they pass through matter, so that their paths are generally far from being straight lines. The "straightened-out" length of the electrons increases with the energy and is about 1 cm at 25 kev, 10 cm for 90 kev, and 100 cm for 0.4 Mev in air at ntp. Since it is frequently necessary to shoot these particles through foils into detection equipment, their penetrating ability for aluminum is of some importance. Roughly, their penetration in aluminum is about 0.0005 that in air, but at high energies the range varies almost linearly with energy, while at low energies it is more nearly proportional to the square of the energy. This is shown graphically in Fig. 4. It is seen that in the region of tens of kilovolts the range-energy relation for electrons having an initial energy E_0 follows roughly the quadratic law:

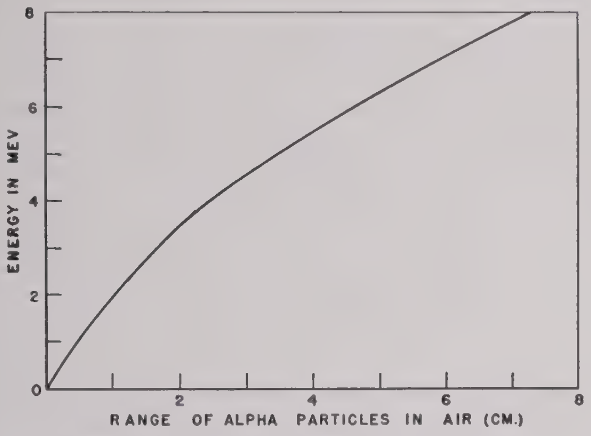


Fig. 3—Range of α particles in air at ntp.

$$R_{1\text{cm}} = 7.5 \times 10^{-7} E_{\text{kv}}^2.$$

The energy E in kv possessed by the electrons after penetrating t grams per square centimeter of material is given by

$$E^2 = E_0^2\left(1 - \frac{13 \cdot 10^5}{E_0^2} t\right).$$

The previous discussion is for high-speed electrons of monokinetic energy. When using these data it should be remembered that radioactive materials emit electrons or positrons with a continuous distribution in energy from zero up to a certain maximum energy ($E_{\max}$) that is characteristic of the particular radioactive isotope.

Properties of Gamma Rays

Gamma rays are similar to X rays of high energy. The distinction between the two lies only in their method of production. As γ rays pass through matter they lose energy by interaction with electrons through the Compton effect, the photoelectric effect, and, when energetically possible, through formation of positive-negative electron pairs. The intensity of a monoenergetic beam of γ radiation passing through an absorber that does *not* interact with the absorber will decrease exponentially as

$$I = I_0 e^{-\mu t}$$

where I_0 is the incident intensity and I is the intensity after having penetrated a thickness t of material (in grams per cm²) of absorption coefficient μ (in cm² per gram). The absorption coefficient is about 0.06, cm²/gram for γ radiation of a few Mev and increases rapidly below 1 Mev. The contribution of the various absorption processes is shown in Fig. 4. The total absorption coefficient has a minimum at about 3.5 Mev and above 8 Mev is nearly entirely due to pair production.

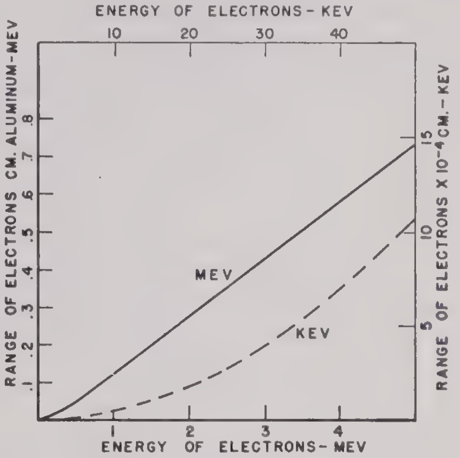


Fig. 4—Range energy of electrons in aluminum.

Radiation Detectors

The various properties of α, β, β_+, and γ radiation as discussed are used in the many types of electronic radiation detectors. A brief summary of the operation of the various electronic devices used for the detection of these radiations follows.

Scintillation Detectors

Certain materials have the property of emitting visible light when bombarded by ionizing materials. Among the more useful materials are zinc sulphide, aluminum oxide, calcium tungstate, anthracene, and napthalene. These materials may be used in the form of powdered material deposited on a backing material, although usually their use as a clear, transparent crystal is preferred. The minute flash of light produced by a single α particle is visible to the eye, provided it is "dark-adapted." The flashes are also capable of being picked up by photomultiplier tubes such as the 1P28 or 931A. With appropriate amplifiers, pulses due to single α, β, β_+, or γ radiations may be detected; and if fissionable material, hydrogeneous material, boron 10, or other materials that react with neutrons be mixed with the fluorescent materials through fission, scattering or nuclear transformations may also be indicated. The electronic circuitry for these detectors is not particularly complex since considerable amplification is attained within the photomultiplier, and it is comparatively simple to obtain pulses 10^{-7} seconds wide from the scintillation detector.

Ionization Chamber Detectors

An ionization chamber is a gas-filled volume into which electrodes are inserted and maintained at a potential difference sufficiently low that gas breakdown or gas amplification does not occur, yet sufficient to collect the primary ionization due to the passage of the ionizing radiation. In integrating types of ionization chambers, a given charge is applied to the electrodes of the ionization chamber, acting as a capacitor. The ionizing radiation then discharges this capacitor and the change in potential difference across the electrodes is read by an electroscope or an electrometer, usually of the filar type. Special electrometer tubes sensitive to lower than 10^{-15} amperes have also been developed for measuring the ionization current produced within the chamber. All types of ionizing radiations are detected by these devices. Generally speaking, instruments of this type have long time constants and are chiefly used where simplicity of operation and low sensitivity (2 to 5000 milliroentgens per hour) are measured.

Pulse Ion Chambers

The alternating-current pulse generated by the ionizing event in an ionization chamber may be amplified and the rate of occurrence of the pulses thus generated may also be used to measure a flux of ionizing radiations. Until recently, the amplified pulse due to the displacement current generated by the motion of the positive ions has been used. At customary strengths of the collecting field, this results in pulse widths which require amplifiers to be peaked at about 1 kc. The motion of the electrons generated by the ionizing event cause a much more rapid pulse to be generated in addition to that due to the positive ions. The mobility of the electrons is much greater than that of the positive ions; therefore, "faster" amplifiers are required, resulting in amplifiers having bandwidths of from 0.2 to 2.0 Mc. In order that pulse heights from the amplifier may be used as a measure of particle energy, pulse amplifiers are usually made linear by means of inverse feedback. The "high-speed" amplifiers have the advantages over the "low-speed" type of comparatively low microphonic noise and higher resolving time.

Proportional Counters

If the field strength within the ionizing volume is increased until "gas amplification" takes place, the size of the pulse, due to the traverse of the ionizing particle, may be considerably increased. When coaxial proportional counters are used, this increased ionization, which may be several thousandfold, is due to high field about the central wire. For this reason amplifiers used with proportional counters need to have much less gain than those used with ionization chambers, and this indeed is the reason proportional counters have replaced ionization chambers for many applications. However, the pulse size obtained from proportional counters is quite sensitive to the voltage across the counter, and the "simpler amplifier" advantage is partially nullified by the additional requirement of a very stable high-voltage power supply.

Geiger Counters

If the voltage across a coaxial proportional counter is increased, the pulse size of the discharge due to an ionizing particle will at first increase and then level off at what is called the "Geiger region." In the "Geiger region" electron avalanches are set up and a continuous gas discharge will result, unless either the voltage is removed from the counter after the ionizing event takes place, or a "quenching gas" is used to extinguish the discharge. Either or both methods are frequently used and offer interesting electronic design problems so as to minimize recovery time and double counting.

Other Detectors of Nuclear Radiations

Photographic films, Wilson cloud chambers, chemical effects, and crystal counters offer other means of radiation detection, of which the crystal counter is of greatest interest to the electronic nuclear instrumentation field. The crystal counters utilize a slab of crystalline material mounted between two high-voltage electrodes. When an ionizing particle strikes crystals of certain types, ionization pulses are produced. The amplifiers and associated electronic equipment are very much the same as that used with the proportional counter; however, since the crystal is of high density, considerably more of the radiation energy is converted to electrical pulses for a unit volume of material than for the case of the gas-filled counters.

Use of Radiation Detectors

The α, β, β_+, and γ radiations emitted from radioactive sources may be measured quantitatively by the various radiation detectors previously discussed. Generally speaking, the various radiation instruments are used as described in Table I. In addition to the applications listed, the α-particle-sensitive devices may be used to measure neutrons, which are nonionizing, by inserting certain materials that react with the neutrons to emit α or fission particles. A typical example of this is the use of a boron-trifluoride atmosphere in a proportional counter, thus permitting the neutrons to interact with the boron to emit an α particle which is then recorded in the customary manner. The nuclear reaction used for this process is given in (1). From this reaction it is seen that the boron 10 (${}_5B^{10}$) isotope is mainly responsible. In ordinary boron only 18 per cent is ${}_5B^{10}$, the remainder being the isotope of mass 11, ${}_5B^{11}$, which

TABLE I

Apparatus	*Particles Detected*	*Range of Intensity*	*Uses and Remarks*
Integrating Ion Chambers	α, β, γ (usually only γ)	0.1 to 100 *r*	Used mainly for health dosimeter. Advantages: compact, simple, rugged.
Ion Chamber with DC Amplification	α, β, γ (usually only γ)	0.001 to 10 *r*/hr	Used mainly for reading radiation flux (*r* rate)
Pulse Ionization Chambers	α, protons, deuterons	Counts single particles up to 10^5 per second	Research-laboratory purposes and monitoring of α radiations.
Proportional Counters	α, protons, sometimes β, γ	Counts single particles up to 10^4 per second	Monitoring of α-particle intensity and measurement of heavy particles in presence of β and γ background.
Geiger Counters	β, γ, sometimes α	Counts single particles up to 10^3 per second	Most-used instrument—counting chiefly β, γ from radioactive materials. May be used for α if necessary. Location of contamination and range dosimetry.
Scintillation Counters	α, β, γ	10 per second up to 10^6 per second	Research purposes requiring high resolution. Probably more extensive uses later.
Crystal Counters	α, β, γ	Single events up to 10^5 per second	Largely research in character at present. Brilliant possibilities.

has one more neutron in its nucleus. It is possible to obtain from the Atomic Energy Commission certain boron compounds enriched in the isotope ${}_5B^{10}$ produced through the use of isotope separators. Use of this "enriched" material as an atmosphere in proportional counters and ionization chambers increases the sensitivity of neutron detectors of this type by roughly a factor of 5.

Electronic Requirements of Radiation Detectors

The characteristics of the various nuclear radiations and instruments capable of detecting and measuring them have been briefly discussed. It remains to consider in greater detail just where electronics may be expected to contribute to the design and operation of these instruments. If one examines any of the various detectors listed in Table I, it becomes obvious that the main content is a maze of electronic tubes and electronic circuitry of ordinary type, but of unusual application. In fact, in most radiation detectors electronics is the "tail that wags the dog." Succeeding papers will discuss in detail the electronic and physical details of these detectors. However, for illustrative purposes, consider the Geiger counter as used in the laboratory for analytical radioactive purposes. For γ-ray counting the "Geiger tube" used is a fundamentally very simple device composed of a copper cylinder 10 cm long and roughly a centimeter in diameter, having an insulated 3- to 10-mil tungsten wire stretched down the cylindrical axis. The tube is surrounded by an envelope enclosing a reduced-pressure atmosphere that, as an example, may be composed of 10 cm of argon and an organic vapor which is usually about 1 cm of ethyl alcohol. Across this tube is imposed about 1000 volts dc. This voltage may be obtained from simple rectification of the output of a 60-cps transformer or, to reduce weight, volume, and filtering required, the rectified output of a 100-kc oscillator is frequently used. When an ionizing event takes place in the tube, a gas discharge takes place. This discharge may be extinguished by the organic vapor present. If, however, long counter-tube life is desired, an electronic extinguishing circuit is used to remove the voltage from the counter after a discharge has been triggered.

Several circuits[4] have been developed for this purpose, each having its own peculiar difficulties and advantages.

The generation and extinction of the gas discharge has lowered and raised the voltage across the Geiger counter tube, thereby indicating the presence within the tube of a single ionizing particle. This pulse, which is a few volts in amplitude and some 10^{-5} seconds wide, is amplified in the conventional manner and fed into an electronic pulse-equalizer circuit and then to either an electronic integrating circuit, to indicate the counting rate, or into a power amplifier that may operate a number register to totalize the pulses. Since electromechanical registers require at least 0.01 second to operate, they place an undesirable limit upon the speed of counting. Consequently, electronic scaling circuits, which permit only a known fraction of the pulses to reach the register, are frequently necessary. It is obvious that, even though the input Geiger counter tube is very simple, a complex array of electronic circuitry is necessary to utilize the device properly and in the most efficacious manner.

The preceding remarks apply only to the Geiger counter. However, if we examine working models of other nuclear radiation detectors, it is apparent that the major portion of their useful operation depends upon appropriate utilization of electronic circuits. This is to be expected, since nuclear detection usually requires fast, reliable indication of phenomena that occur at a very low voltage level. The application of electronic methods and circuits naturally offers the more obvious solutions to these problems. In fact, electronic applications to the detection, indication, and measurement of nuclear radiations represent the most apparent, but by no means the only, field of application to nuclear science.

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[4] J. Strong, "Proceedings in Experimental Physics," Chap. VII, p. 259, Prentice-Hall, Inc., New York, N. Y., 1938.

Electronics and Nuclear Particle Accelerators

The application of electronics to the vast number of accelerators has been no less spectacular. In fact, the world's most powerful oscillators are being developed for use in the larger cyclotrons. Whether the nuclear accelerator be a synchrocyclotron or a cavity linear accelerator, the electronics expert finds countless electronic problems that have been previously unsolved and, consequently, tax his ingenuity to the utmost.

Electronics and the Future of Nucleonics

As time passes, nuclear electronic applications and problems seem to increase in number, thus offering to the engineer a bright new field of the future, fraught with difficulty, but great in interest.

On the other hand, the electronics part of the nuclear sciences presents a challenge to the electronics engineer. In this borderline or dual subject, it is not sufficient for the electronics expert to be capable in his own field. He must also be an expert in nucleonics. Since the science of nuclear phenomena is a new field, the nuclear expert is not always able to put his electronics problems to the electronics expert in the proper language so that he may obtain the benefit of his thinking and experience. It is usually necessary for the electronics scientist to follow the nuclear problems involved, and to find and point out the defects in existing techniques and to offer new solutions to these difficulties. To do this, he must have a sound understanding of the basic phenomena in nuclear physics, in addition to his electronics training. While this may appear to be too much to expect, there is no substitute for this combination of knowledge. To those that qualify, new horizons are opening up, second in importance to none, and with tremendous capabilities for the good or the destruction of mankind.

Considerations in the Design of a Universal Beacon System*

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Summary—Airborne beacons are an essential element in aircraft navigation and traffic-control systems since they provide a means of (a) radar range extension and (b) intelligence transmission. However it is important that a universal beacon be provided which will, in effect, operate with all ground and airborne radar equipments, regardless of the operating frequency of the primary radar equipment. Also, the airborne beacon must provide the maximum of facilities for intelligence transmission. The paper outlines the specifications for a proposed universal beacon system satisfying the above basic requirements, and discusses certain design criteria for the several components of the proposed system.

I. Introduction

AIRBORNE BEACONS or transponders have, during the past few years, received considerable attention by both military and civil agencies because of their universal application to aircraft navigation and traffic-control systems.[1,2] It has been found, in particular, that airborne radar beacons show considerable promise of contributing to the solution of two problems commonly associated with all such systems; i.e., (1) radar range extension, or "radar assist," and (2) automatic intelligence transmission. In fact, it has been shown that airborne transponder beacons are capable of performing so many essential functions that the problem is no longer one of deciding if a beacon is required; rather, the problem has become one of deciding how many functions can be accomplished by a simple beacon, or of deciding how many beacons must be carried in a single aircraft to accomplish essential functions. It is, of course, desirable to carry only one small, light-weight beacon in the aircraft. This situation received careful consideration during the recent deliberations of Special Committee No. 31, which was established by the Radio Technical Commission for Aeronautics to determine the basic system considerations and equipment types required for a nationwide air navigation and traffic-control system.[3] The material presented in this paper is believed to be essentially in

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† Communication and Navigation Laboratory, Air Materiel Command, Wright Field, Dayton, Ohio.

[1] Ralph D. Hultgren and Ludlow B. Hallman, Jr., "The theory and application of the radar beacon," Proc. I.R.E., vol. 35, pp. 716–730; July, 1947.

[2] Arthur Roberts, "Radar Beacons," vol. 3, MIT Rad. Lab. Series, McGraw-Hill Book Co., Inc., New York, N. Y., 1947.

[3] "Air Traffic Control," prepared by RTCA SC-31, Paper 27-48/DO-10, May 12, 1948, Radio Technical Commission for Aeronautics, Rm. 597, Department of State Bldg., 17 St. and Pennsylvania Ave., Washington 25, D. C.

accord with the applicable guiding principles established by SC-31. The purpose of the paper is to outline basic requirements. A discussion of detail techniques will not be attempted.

II. The Problem of Radar Range Extension

Small aircraft, particularly those with fabric-covered airfoil and fuselage surfaces, make poor radar targets, especially under adverse weather conditions, and are often difficult to detect beyond a few miles from the radar site. These aircraft become hazards when the ground radar equipment is used to control the traffic pattern around the airport. If all such aircraft were equipped with radar beacons, this problem would, of course, be much less serious. To be universally effective, the airborne beacon must, in effect, respond to all ground and airborne navigational radar frequencies, and any universal beacon system must satisfy this requirement. It also follows that the airborne beacon must be so designed that it is effective out to the maximum operating range of the associated primary radar equipment.

III. The Problem of Automatic Intelligence Transmission

It is convenient to divide the intelligence to be transmitted, both air-to-ground and ground-to-air, into two fundamental types, as follows: (a) intelligence which is fundamental to the air traffic-control system; and (b) intelligence which is fundamental to the navigation of the aircraft.

In establishing the principles upon which the universal beacon system is based we propose that the universal airborne beacon be required to handle only that form of intelligence transmission which is fundamental to the air traffic-control system.

The following types of intelligence, listed in order of operational importance, are fundamental to the air traffic-control system and should, therefore, be capable of automatic transmission to the ground traffic-control agency through the universal beacon system: (a) aircraft range and azimuth (automatically provided in connection with the radar-assist or range-extension function described above); (b) aircraft altitude; and (c) aircraft identity.

In addition to the above, the proper control of the air traffic requires a private-line communication channel between ground control and each aircraft, for the automatic transmission and reception of routine traffic-control intelligence such as "clear to land," "increase altitude to———," "decrease altitude to———," "hold," "ahead of schedule," "behind schedule," "turn right —— degrees," "turn left —— degrees," etc. Also, the private-line communication channel may be used to indicate the failure of the system at any point. It is probable that all such information required could be transmitted using a four- or five-pulse binary code.

IV. Proposed Specifications for the Universal Beacon System

a. General

Consideration of the basic problem, as outlined in the foregoing, leads to the following conclusions regarding the over-all system:

(1) The airborne transponder should be so designed that its reply signal is capable of being seen on the display of any pulse-type ground or airborne radar equipment operating in the approximate frequency range of 100 to 20,000 Mc. The use of an interrogator-responser equipment operating in a common frequency band provides a convenient means of satisfying this requirement, and a brief description of such equipment will be given later in this paper. Assignments have been provided in the bands 960–1215 and 1300–1660 Mc for aeronautical radio aids. It is proposed that the common interrogator-responser channel be assigned in one of these bands.

(2) The characteristics of the airborne beacon (secondary radar) system should be such that its operating range, azimuth, and range definition is at least as great as that of the highest-power (greatest-range) primary radar equipment with which it will be used, when the primary radar equipment is operating at maximum range against an effective reflecting area equivalent to, say, a close formation of six aircraft of the DC-6 type. The beacon system should also provide satisfactory operation down to a minimum of at least 1/2 mile range at an altitude of 1000 feet.

(3) When the azimuth and range definition of the primary radar equipment is greater than that which is practicable at the selected common beacon interrogator-responser frequency, then simultaneous or dual interrogation at the primary radar frequency may be required. Even when this is not necessary, however, the L-band common interrogator-responser channel is extremely useful in that it provides a means for preventing overinterrogation, or saturation, of the transponder by spurious radar signals. Also, the L-band channel may be used to provide a coded signal for adjusting the sensitivity of the transponder receiver to provide improved azimuth resolution when the aircraft is less than, say, ten miles from the ground radar equipment.

(4) The capability of supplying the types of data indicated below should be provided by the universal beacon system.

(i) *Radar Assistance.* (Both range and azimuth.) This constitutes the basic radar-beacon function.

(ii) *Altitude.* It appears technically feasible to provide aircraft altitude data by suitable interrogation or reply codes, frequency channeling, or by a combination of pulse codes and frequency channeling. Further study will be necessary before a decision can be made as to just how this facility may be best provided. System requirements indicate a need for 20 altitude layers, although a continuous indication of altitude may ultimately prove the more desirable.

(iii) *Identity.* The simultaneous display of the identity of all aircraft is not required. Rather, provision should be made for the display of the identity of particular aircraft upon request. The period of time between the selection of the target and the display of the identifying information required should be as short as practicable and preferably less than ten seconds.

There are two fundamental types of identity to be considered; namely, identity of the "Who are you?" type, and identity of the "Where are you?" type.

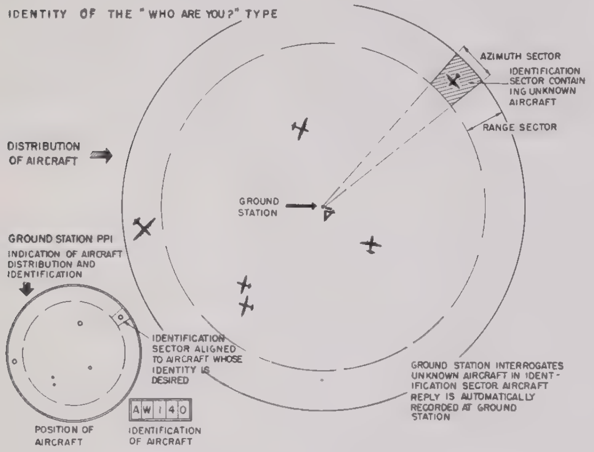
IDENTITY OF THE "WHO ARE YOU?" TYPE
AZIMUTH SECTOR
IDENTIFICATION SECTOR CONTAINING UNKNOWN AIRCRAFT
RANGE SECTOR
DISTRIBUTION OF AIRCRAFT
GROUND STATION
GROUND STATION PPI
INDICATION OF AIRCRAFT DISTRIBUTION AND IDENTIFICATION
IDENTIFICATION SECTOR ALIGNED TO AIRCRAFT WHOSE IDENTITY IS DESIRED
AW140
POSITION OF AIRCRAFT
IDENTIFICATION OF AIRCRAFT
GROUND STATION INTERROGATES UNKNOWN AIRCRAFT IN IDENTIFICATION SECTOR AIRCRAFT REPLY IS AUTOMATICALLY RECORDED AT GROUND STATION

Fig. 1—Display of identity of the "Who Are You?" type as applied to the universal beacon system.

Identity of the "Who are you?" type is illustrated in Fig. 1. Here the interrogation is limited to the particular air-space segment in which the unknown aircraft is located. Azimuth definition is obtained from the directivity of the L-band ground antenna. Range identity may be obtained by a pulse code which is controlled by the range position of the unknown aircraft as viewed on the ground-equipment plan-position indicator (PPI). Both the azimuth positioning of the interrogator-responser L-band antenna and the range identity pulse-code adjustment are automatically accomplished when the ground traffic controller adjusts the cross hairs of his range and azimuth cursors so that they cross over the spot on the PPI displaying the unknown aircraft. In the aircraft, provision is made to utilize the airborne distance-measuring equipment (DME) to establish a decoding circuit, such as a double-pulse gate, which will pass the identity interrogating pulse only if it is properly coded to correspond to the aircraft's distance from the ground station. Use of the airborne DME to establish range identity requires that the ground beacon used with airborne equipment be suitably located with respect to the ground radar and interrogator-responser equipments. Also, the same ground beacon must be used by all aircraft in a given control area. Where this is not feasible, identity of the "Who are you?" type must be accomplished using azimuth discrimination only. Ultimately, it may be found advantageous to further limit the air space interrogated for identity of the "Who are you?" type by interrogating only that altitude sector occupied by the unknown aircraft.

Identity of the "Where are you?" type is illustrated in Fig. 2. This type of identity is provided when the aircraft equipment automatically, or the aircraft pilot or navigator manually, operates a control which causes a special identifying signal to be transmitted when the ground controller broadcasts a request for this type of identity either by radiotelephonic or coded interrogation means; or by means of a special interrogation over the private-line circuit.

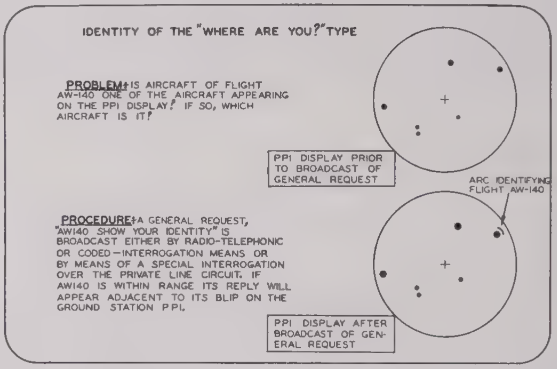
IDENTITY OF THE "WHERE ARE YOU?" TYPE
PROBLEM: IS AIRCRAFT OF FLIGHT AW-140 ONE OF THE AIRCRAFT APPEARING ON THE PPI DISPLAY? IF SO, WHICH AIRCRAFT IS IT?
PPI DISPLAY PRIOR TO BROADCAST OF GENERAL REQUEST
ARC IDENTIFYING FLIGHT AW-140
PROCEDURE: A GENERAL REQUEST, "AW140 SHOW YOUR IDENTITY" IS BROADCAST EITHER BY RADIO-TELEPHONIC OR CODED—INTERROGATION MEANS OR BY MEANS OF A SPECIAL INTERROGATION OVER THE PRIVATE LINE CIRCUIT. IF AW140 IS WITHIN RANGE ITS REPLY WILL APPEAR ADJACENT TO ITS BLIP ON THE GROUND STATION PPI.
PPI DISPLAY AFTER BROADCAST OF GENERAL REQUEST

Fig. 2—Display of identity of the "Who Are You?" type, showing a problem, and the procedure to be followed.

(iv) *Private-Line Communication.* It is proposed that a separate communication channel, consisting of one transmitting and one receiving frequency, be set aside in the 960- to 1660-Mc band, and designated specifically for automatic intelligence transmission of the type which is required in connection with the universal beacon system.

Since it is required to handle all aircraft within range on this single communication channel, some method of time division is required. We may, for example, choose a 6-second cycle. If each aircraft is assigned a 3000-microsecond interval in each 6-second cycle, two thousand aircraft can be handled in a given area on the same pair of frequencies. This requires synchronization of all ground stations and all aircraft equipments in the area. This requirement could be satisfied by utilizing the rotational rate of the navigational omnirange pattern as the source of synchronization voltage. Intelligence would be transmitted by means of suitable binary codes.

b. Airborne Components

The airborne transponder components of the universal beacon system are illustrated diagrammatically in Fig. 3. L-band transmitter No. 1 with its associated decoder and modulator provide the radar assist (range and azimuth), aircraft altitude, and aircraft identity functions. L-band transmitter No. 2 and its associated decoder and modulator provide the private-line communication facility.

Only S- and X-band coincident-channel receivers are provided, since it does not appear at present that coincident interrogation at other frequencies will be a requirement within the next ten years.

It is proposed that the inherent delay of all airborne transponders in replying be standardized to remain constant under all service conditions to within ±0.2 microsecond, so that resulting range inaccuracies from this source shall not exceed ±100 feet.

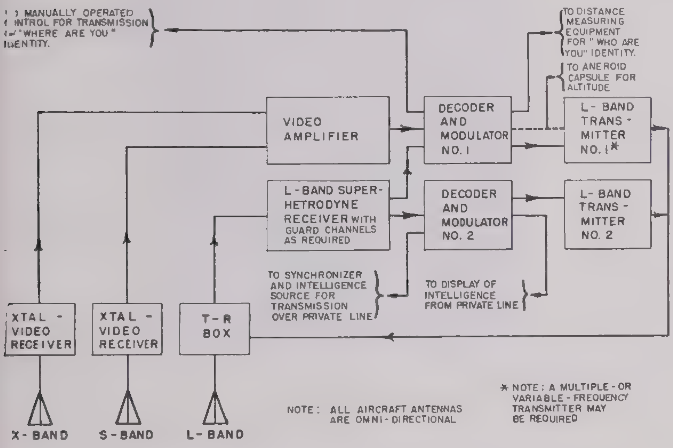
MANUALLY OPERATED
INTROL FOR TRANSMISSION
"WHERE ARE YOU"
IDENTITY.
TO DISTANCE MEASURING EQUIPMENT FOR "WHO ARE YOU" IDENTITY.
TO ANEROID CAPSULE FOR ALTITUDE
VIDEO AMPLIFIER
DECODER AND MODULATOR NO. 1
L-BAND TRANS-MITTER NO. 1*
L-BAND SUPER-HETRODYNE RECEIVER WITH GUARD CHANNELS AS REQUIRED
DECODER AND MODULATOR NO. 2
L-BAND TRANS-MITTER NO. 2
TO SYNCHRONIZER AND INTELLIGENCE SOURCE FOR TRANSMISSION OVER PRIVATE LINE
TO DISPLAY OF INTELLIGENCE FROM PRIVATE LINE
XTAL-VIDEO RECEIVER
XTAL-VIDEO RECEIVER
T-R BOX
X-BAND
S-BAND
L-BAND
NOTE: ALL AIRCRAFT ANTENNAS ARE OMNI-DIRECTIONAL
* NOTE: A MULTIPLE- OR VARIABLE-FREQUENCY TRANSMITTER MAY BE REQUIRED

Fig. 3—Airborne transponder components of the universal beacon system.

In addition to the airborne transponder components illustrated in Fig. 3, an L-band interrogator-responser unit is proposed for aircraft carrying navigational-type radar equipment. The unit should have facilities provided for interconnection with any standard airborne radar system. However, it should also be capable of satisfactory operation independently of the airborne radar equipment.

The receiving system should be capable of receiving a selectable range of altitude-indicating signals.

It is suggested that the beacon reply be displayed on the indicator of the associated airborne radar equipment when such is available. For use in nonradar-equipped aircraft, a suitable display unit should be provided. The identity information could be displayed separately, and it is not necessary that the airborne equipment display the identity of all beacon replies.

c. Ground Components

The proposed ground components of the universal beacon system are diagrammatically illustrated in Fig. 4. Although only one L-band directional antenna is shown in Fig. 4, it is likely that two such antenna systems may be found operationally desirable. One would be used for continuous automatic azimuth tracking, the other would be rotated or controlled manually for obtaining aircraft identity without interference with the automatic-tracking function.

Facilities should be provided for interconnection with any standard ground radar system, though the interrogator-responser equipment should also be capable of operation independent of the ground radar equipment.

The receiving system should be capable of receiving and displaying a selectable range or the entire range of altitude-data signals.

It is suggested that the beacon reply be displayed on the same type of indicator or the same indicator as the radar. The "radar assist" function and altitude information should be available continuously. The identity information may be displayed separately.

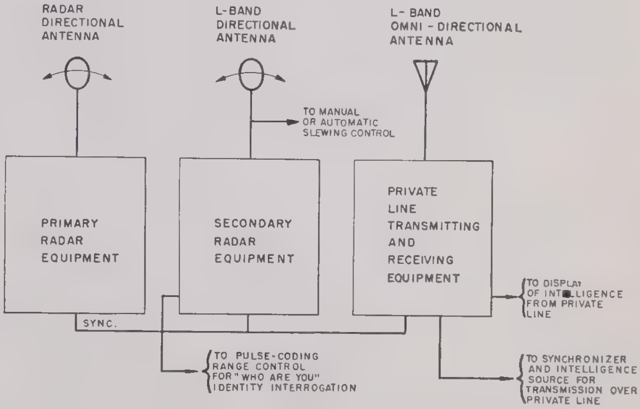
RADAR DIRECTIONAL ANTENNA
L-BAND DIRECTIONAL ANTENNA
L-BAND OMNI-DIRECTIONAL ANTENNA
TO MANUAL OR AUTOMATIC SLEWING CONTROL
PRIMARY RADAR EQUIPMENT
SECONDARY RADAR EQUIPMENT
PRIVATE LINE TRANSMITTING AND RECEIVING EQUIPMENT
TO DISPLAY OF INT[illegible]LLIGENCE FROM PRIVATE LINE
SYNC.
TO PULSE-CODING RANGE CONTROL FOR "WHO ARE YOU" IDENTITY INTERROGATION
TO SYNCHRONIZER AND INTELLIGENCE SOURCE FOR TRANSMISSION OVER PRIVATE LINE

Fig. 4—Ground components of the universal beacon system.

Acknowledgment

The author wishes to acknowledge the contribution by personnel of the Communication and Navigation Laboratory, Wright-Patterson Air Force Base, in the general study of the universal beacon system. It is especially desired to acknowledge the assistance of S. A. Mundell, formerly Chief, Communication and Navigation Laboratory, and N. Braverman, Assistant Chief Engineer, Communication and Navigation Laboratory, in reviewing and criticizing the manuscript, particularly from the standpoint of their experience in working with RTCA Special Committee No. 31.

Three-Dimensional Representation on Cathode-Ray Tubes*

CARL BERKLEY†, ASSOCIATE, IRE

Summary—**A procedure for the representation of functions of a number of variables on the screen of a cathode-ray tube is developed. The procedure may be applied to any regular system of coordinates or any number of variables. The representation may take the form of an oblique perspective picture. The procedure consists of the following steps:**

1. **Setting the form of the representation.**
2. **Deriving the position of the spot on the cathode-ray tube as a function of its true position in space.**
3. **Making the indicated corrections electrically.**

Applications in the fields of mathematics, radar, electromagnetic theory, mechanical measurements, topographic surveying, and meteorology are described.

INTRODUCTION

PATTERNS WHICH give the illusion of a three-dimensional object are frequently encountered in work with cathode-ray tubes. These patterns are sometimes obtained intentionally, but more usually occur as a result of some cross coupling, oscillation, or defect in the circuits used. An analysis of such patterns was undertaken to find if they could be reproduced at will, and whether use could be made of the results. It was found that analysis is simple in many cases, and it is expected that the results will find wide application. Examples of such patterns appear in Figs. 2–5 and 8, which are photographs directly from the face of a cathode-ray tube. Since the same cathode-ray-tube pattern is viewed by both eyes in the majority of cases, it will be obvious that these pictures can only be representations or perspective projections which, at the most, can give an illusion of three dimensions. Two separate and distinct patterns, each viewed by one eye, are necessary to give the true effect of depth for the observer. Schmitt[1] has independently arrived at the electrical and optical conditions which must be satisfied for true stereographic representation, in addition to those to be described for the metrical projections.

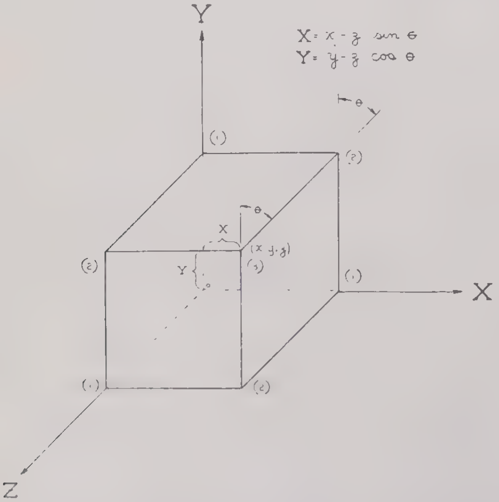

Fig. 1—Figure for the derivation of translating voltages for oblique representation.

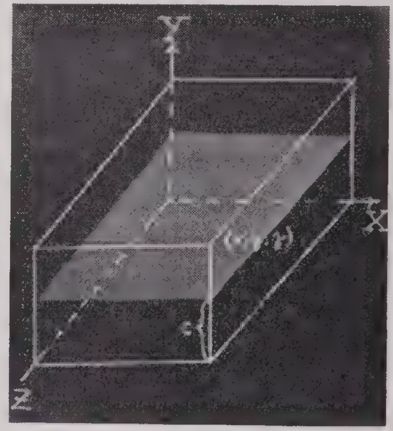

Fig. 2—Representation of the plane: $y-c=0$
V signal = 15-cps sawtooth
H signal = 3-kc sawtooth + 15-cps sawtooth.

An analysis of the geometry of perspective drawings shows that the procedures used in conventional representations may be expressed by mathematical notation. As an example, this may be very readily done as follows for the so-called "oblique" perspective representa-

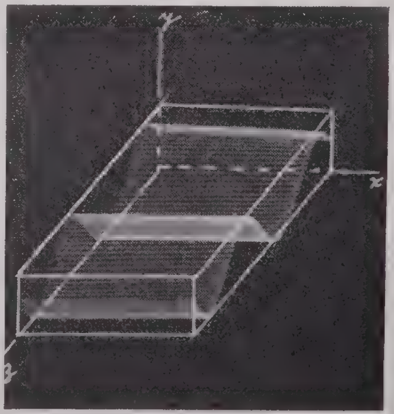

Fig. 3—The surface: $A \sin z-y=0$
V signal = 30-cps sawtooth − 60-cps sine wave
H signal = 1.5-kc sawtooth + 30-cps sawtooth.

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* Decimal classification: R201.7×621.375.9. Original manuscript received by the Institute, April 14, 1947; revised manuscript received, June 7, 1948. Presented, 1947 IRE National Convention, March 5, 1947, New York, N. Y.

† Allen B. DuMont Laboratories, Inc., Clifton, N. J.

[1] O. H. Schmitt, "Cathode ray presentation of three dimensional data," *Jour. Appl. Phy.*, vol. 18, pp. 819–829; September, 1947.

tion most used in mathematical and engineering work. Let x, y, and z be the co-ordinates of a point in three-dimensional space represented by an oblique projection in Fig. 1. X and Y are the co-ordinates in the two-dimensional representation on the cathode-ray-tube face. If the origin is the same in both spaces and θ is the angle the Z axis makes with the Y axis in the projection, then it is evident from the geometry of the figure that

$$X = x - z \sin \theta \qquad (1)$$

$$Y = y - z \cos \theta. \qquad (2)$$

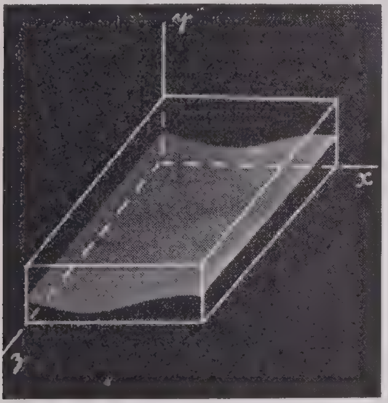

Fig. 4—The surface: $A \sin x + y = 0$
V signal = 60-cps sawtooth + 3-kc sine wave
H signal = 3-kc sawtooth + 60-cps sawtooth.

These formulas show that, for a proper oblique representation, to the x value of the function in space must be added a certain fraction of the z value at that point to get the proper crt co-ordinate in the X or horizontal direction. Similarly for the y value. If z is the independent variable, z may be given a form such as a sawtooth function, in which case it is only necessary to add to the x and y values sawtooths whose value is multiplied by $\sin \theta$ and $\cos \theta$. This has been done in Figs. 2–5 in the text, using the circuit shown schematically in Fig. 6. The results show that it is possible, at least for the oblique representation, to represent these functions by the simple addition of properly obtained electrical values to the deflection plates. Any empirically desired values can readily be obtained by electronic means; for instance, by scanning, photoelectrically, a printed image of the function by a slit.[2] Consider the usefulness of this method. In any mathematical analysis of a complicated function, expressions are arrived at which are extremely difficult to visualize merely from the formulas. By translating these functions into electrical values, these otherwise unimaginable properties can be readily made visible, and the correspondence in shape between functions which appear unrelated when expressed as formulas can be easily recognized.

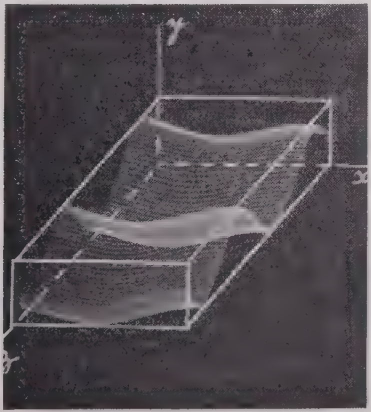

Fig. 5—The plane: $A \sin x - y + B \sin z = 0$
V signal = 30-cps sawtooth + 1.5-kc sine wave + 60-cps sine wave
H signal = 1.5-kc sawtooth + 30-cps sawtooth.

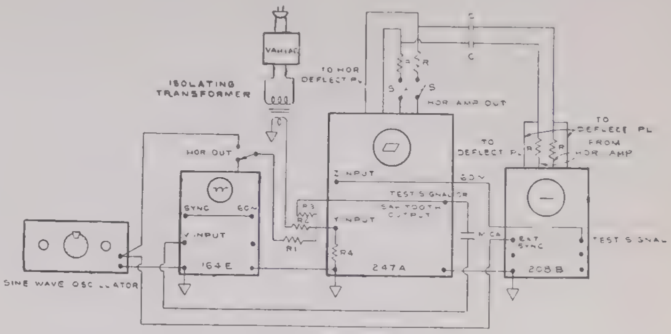

Fig. 6—Schematic for production of three-dimensional patterns.

Procedure

While the procedure which is used here is described for up to three variables, it will likewise be useful for the two-dimensional representation of any number of variables, once the form of the projection is agreed upon. While the illustration is also limited to the case of the oblique projection, it will be evident that other projections can be similarly treated.

An equation in three variables evidently represents a surface. This surface may be an abstract mathematical function or, as shown later, may be that of a real object, such as the surface of a cylindrical piston, which can be expressed analytically, or a topographic map, which cannot. When an analytically expressed surface is to be plotted, the usual procedure is to allow the independent variables to assume all values between the limits desired and then plot the values of the function. This generally entails a tremendous amount of work. However, in many cases the effort is justified by the importance of the results.[3]

It is possible to represent a variable on a cathode-ray tube and to make the variable assume all values within limits by very simple electrical means. This can be done, for example, by applying a sweep voltage as the independent variable or variables. The peak-to-peak values of the sweep, which need not necessarily be a sawtooth, are chosen to correspond to the limits within which it is desired to plot the variable. The corrections of (1) and (2) are then necessary to produce the particular projection desired for an oblique perspective representation.

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[2] R. C. Walker, "Electronic Equipment," Chemical Publishing Company, 1945, p. 143.

[3] E. Jahnke and F. Emde, "Funktionentafeln," Dover Publications, 1943.

In order to assume all the values within limits in an area, it is necessary, of course, to use two sweeps at right angles to one another which scan this area. To cover a solid, it is necessary to use three sweeps essentially at right angles. If sweeps are chosen for the x and z values, the mathematical corrections required in (1) and (2) can be seen to represent the addition of a portion of the z sweep to the x and y signals; that is, to the horizontal and vertical deflection plates. The application of this method will now be described for a number of cases.

Fig. 2 evidently represents a plane whose formula is

$$y - c = 0 \qquad 0 < x < x_1,\ 0 < z < z_1$$

in which x and z are independent variables.

In this case the two sweeps which were chosen to cover the area were synchronized 15-cps and 3-kc sawtooth sweeps. These may be expressed by

$$x = nkt \tag{3}$$

for the actual value of one sweep in three-dimensional space in the x direction, and

$$z = kt \tag{4}$$

for another sweep in the x, z plane

where t = time
k = a constant
n = frequency ratio between sweeps.

Then, applying the operation of (1) to the X coordinate on the oscillograph by substituting the value of X from (3) in (1) to find the horizontal deflection for proper representation, we obtain

$$X = nkt - kt \cos \theta$$

Since $\cos \theta$ is constant, $k \cos \theta = k_1$, which changes the previous formula into

$$X = nkt - k_1 t. \tag{5}$$

This can be seen to be the algebraic sum of the high-frequency sweep and a fraction, $\cos \theta$, of the low-frequency sweep. This is the signal applied to the horizontal deflection plates in Fig. 2. To find the Y deflection, we apply the indicated correction to the function

$$y - c = 0,$$

obtaining for the Y value, or vertical deflection voltage,

$$\begin{aligned} Y &= c - kt \sin \theta \\ &= c - k_2 t, \quad \text{where} \quad k \sin \theta = k_2. \end{aligned} \tag{6}$$

The c in this equation represents the vertical positioning voltage, and $k_2 t$ is proportional to the Z signal, which value can be obtained by adjusting the Z-sweep gain.

A useful accessory for setting up the proper amplitudes is a DuMont type 264A voltage calibrator. If, for example, 1 volt is selected as representing one unit of the independent variable z, and $\cos \theta = 0.707$, then the vertical sweep signal amplitude is set at 0.707 volt peak-to-peak as read on the 264A to represent $0 > z > 1$. The value of C may be read with a voltmeter on the positioning voltage or by having the positioning control directly calibrated.

A similar analysis can obviously be carried through for other functions. Consider the surface $A \sin z - y = 0$.

An analysis of this formula shows that it can be represented as follows:

On the vertical plates is produced the algebraic sum of

$$y = k_3 t,$$

the sweep, and

$$y = A \sin z.$$

On the horizontal plates is produced the sum of

$$x = nk_3 t - k_4 t,$$

which is the algebraic sum of the high- and low-frequency sweeps. This surface is shown in Fig. 3.

Consider Fig. 4, which is similar to Fig. 3. The equation of this surface is

$$A \sin x + y = 0.$$

This is similar to Fig. 2 except that the wave is traveling down the X axis. The figure is seen (after analysis) to be obtained by putting on the vertical plates the sum of the functions:

$$y = -\sin x, \quad \text{and} \quad y = kt, \quad \text{or,}$$

expressed as a single waveshape,

$$y = kt - \sin x,$$

and on the horizontal plates, the sum of

$$x = -kt \quad \text{and} \quad x = nkt, \quad \text{or}$$

$$X = nkt - kt.$$

Putting this into electrical terms, we again see that on the vertical plates there is the algebraic sum of a sawtooth and sine-wave function, and on the horizontal plates the sum of two sawtooth functions.

It will be seen, upon study of these last three diagrams, that the illusion of a perspective drawing is given essentially by scanning the area with the two sawtooth voltages and by adding a portion of the vertical-deflection sawtooth to the horizontal plates to give the illusion of a Z plane in space. Once this is realized, it will be fairly easy to convert from the formulas to the desired pattern and back merely by inspection.

The equation for the surface in Fig. 5 is $A \sin x - y + B \sin z = 0$. This can be readily visualized from Fig. 5 as a surface resulting from the combination of two sine waves traveling along the x and z axes.

Figs. 3 and 4 may represent the magnetic field intensity between the walls of a waveguide, neglecting boundary conditions (that is, assuming the side walls have no effect), if the waves are traveling at right angles to each other.[4]

Fig. 5 shows the sum of the magnetic field intensities produced by these waves.

REPRESENTATION OF FUNCTIONS OF THREE VARIABLES

A function of one variable, $f(x)=y$, requires a two-dimensional surface (a plane) for its representation. A function of two variables requires a three-dimensional surface as in Figs. 2–5. Reasoning by extension requires a four-dimensional figure to represent a function of three variables $f(x, y, z)=u$. For a generalized representation, however, and with the restriction that the result is an arbitrary convention, and not a four-dimensional figure, any representation on a plane surface (such as a cathode-ray-tube face) may be used from which the values of x, y, z, and u can be read at any point. To produce such a representation, it is necessary to find one additional parameter which can be easily recognized on a cathode-ray tube. The one additional variable already available on most oscillographs is the brightness. This may be chosen to represent the value of u. This value can then be measured by reference to a source of calibrated brightness or by a comparison of the beam current obtained at any point in the function.

The appearance of many simple functions plotted in this manner can be easily visualized and they can be readily produced. Consider the equation

$$x + y + z = u \qquad \begin{array}{l} 0 < x < 1 \\ 0 < y < 1 \\ 0 < z < 1. \end{array}$$

This is represented on the cathode-ray tube by a three-dimensional cube similar to Fig. 1, in which any point has a brightness equal to the sum of the x, y, and z values at that point. This can easily be produced on an oscillograph by adding the x, y, and z components of the signal and applying the sum to the blanking amplifier. In Fig. 1, the numbers in parenthesis indicate the value of the function, and therefore the brightness of the corresponding corners of the cube. This pattern has actually been produced, but is not shown since the reproduction process does not adequately represent the slight brightness shadings which exist.

EXPERIMENTAL SETUP OF PATTERNS

Fig. 6 shows schematically the experimental setup used to produced Figs. 2–5. The final representation appears on the screen of the DuMont type 247A projection oscillograph. The 164E produces a sweep at some submultiple of 60 cps. The variac produces a variable 60-cps wave which is adjusted to obtain the proper vertical amplitude in Figs. 3 and 5. The 208B produces the 3-kc sweep in Figs. 2–5. The sine-wave oscillator generates the 3-kc sine wave in Figs. 4 and 5. The network consisting of resistors R_1 to R_4 adds the signals from the 247A sawtooth output, the variac, and the 164E or the oscillator, as may be shown from the superimposition theorem. The resistors are chosen of a large enough value so that each generator output is not loaded down by the internal impedances of the others in parallel. For demonstration purposes, the 247A is used as a projection oscillograph. To heighten the illusion of three dimensions, the co-ordinate axes or the limits to which the variables are permitted to explore may be projected separately or by electronic means. The axes have been drawn in the figures for this purpose. A certain percentage of the observers have difficulty in visualizing the shape of a surface or volume unless the axes are so indicated.

To produce Fig. 2, only the 247A and 208B are needed. The high-frequency sweep of the 208 is added to the low-frequency sweep from the horizontal amplifier and applied to the horizontal deflection plates of the 247. The sweep in the 247 is also taken from the front panel output and applied to the vertical amplifier. By varying the gains of the amplifiers, the constants in (5) and (6) may be adjusted so that the angle at which the projection is viewed may be changed at will. By varying the frequencies and adding a third sawtooth from the 164E, either the top or bottom of the figure may be viewed or a series of planes one above the other will be displayed, as will be evident after consideration of the motion of the spot. By using potentiometers ganged so as to control the value of θ, the pattern may be rotated at will to examine various aspects of the figure on the screen.

Fig. 3 may be produced by adding the output of the variac to the vertical deflection. Fig. 4 is produced by turning the variac to 0 and applying the sine-wave oscillator output instead. Fig. 5 is produced by adding both sine waves of the same amplitude.

The function $x+y+z=u$ can be produced by adding to the sweeps of Fig. 2 a third sweep applied as the independent y variable and obtained from the 164E. The sum of these three sweeps is then produced separately and applied to the blanking amplifier of the 247.

OTHER APPLICATIONS

1. *Mathematics:* The use of apparent three-dimensional representation of mathematical functions on a cathode-ray tube has been covered above. The costly and laborious drawings for mathematical and theoretical texts can be greatly facilitated by producing such patterns on a cathode-ray tube and making a photographic record.

2. *Electromagnetic Fields:* This method will be very useful in the correct adjustment and study of uhf

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[4] J. Skilling, "Fundamentals of Electric Waves," John Wiley & Sons, Inc., New York, N. Y., 1942; figs. 57 and 58, p. 33.

resonators, couplings, and transmitters. The wave patterns in Figs. 2–4 can be obtained in an actual case by using a moving pickup probe whose motion is synchronized with that of the spot. Any other spatial field distribution, such as in acoustics, hydrodynamics, aerodynamics, optics, and fluid mechanics, can be plotted with appropriate pickup devices.

3. *Topographic Surveying and Meteorology:* By applying a third sweep to the sum of the two functions on the vertical plates, it is possible to make the locus of the spot appear to scan a volume. For example, in Fig. 2, by adding to the vertical sawtooth signal another voltage

$$y = \frac{kt}{n}$$

where k/n is a submultiple of the other sweeps, the volume shown in the figure will be scanned. This volume may be used to represent a certain section of the earth's surface being mapped by an airplane flying above it, as shown in Fig. 7. By properly arranging to brighten the beam or displace it, depending upon the reflected rf pulses, a three-dimensional picture of the territory will be shown. This may be used similarly for meteorological purposes, since it is possible to so gate the transmitter and receiver as to scan only a particular volume of the aerosphere. This method would make possible the indication of the contour of a cloud or storm formation, in addition to its size and location.

4. *Radar Indication of Azimuth, Range, and Elevation:* The same principles obviously can be applied to radar. By putting in three sets of controls for a movable marker spot, it is possible to blank in a particular spot in the volume scanned and then read off azimuth, range, and elevation from the three controls. In order to heighten the illusion of perspective for these last two applications, it may be desirable to modulate the size of the pattern from one end to the other by means of keystoning or intensifier potential modulation, as is indicated in Fig. 7. A typical example of the type of pattern to be expected from such radar or topographic application is shown in Fig. 8. This shows approximately what can be expected from the shore line of a river with a road over a pontoon bridge crossing the river. This was actually obtained by height-modulating the $y=c$ plane in Fig. 1 by the addition of a sharp vertical pulse synchronized with the sweeps. The exact occurrence of the pulse was varied during the z-sweep cycle.

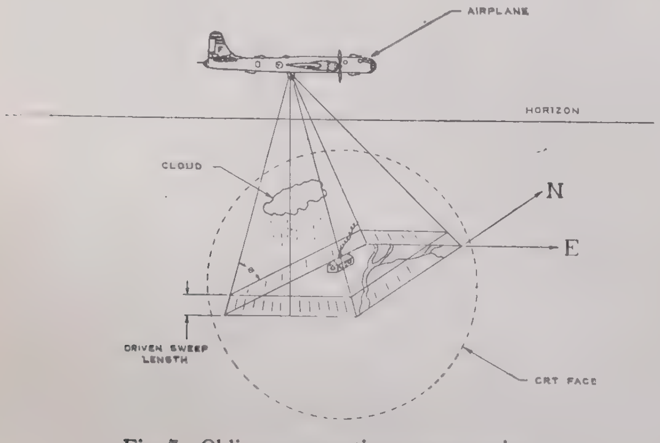

Fig. 7—Oblique perspective representation.

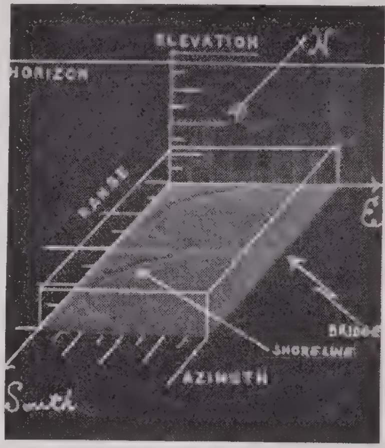

Fig. 8—Simulated radar pattern such as may be obtained from a bridge and the shoreline of a river.
V signal = 30-cps sawtooth + sharp pulse at 3-kc average repetition rate.
H signal = 3-kc sawtooth + 60-cps sawtooth.

Another radar representation that may be improved by the use of these techniques is the PPI. If the vertical gain is reduced, the circular field appears ovoidal as if viewed from a point in space outside the area being scanned and not directly over the transmitter. The video information may then be clipped to eliminate the noise and applied as an addition to the vertical deflection. This gives a picture in which an untrained observer can readily recognize objects which otherwise would be merely dark or bright blobs on the map. If some video is added to the grid, as well, mountains may be seen as bright projections from the flat earth plane.

5. *Mechanical Measurements:* Fig. 9 shows a setup for scanning the surface of an engine piston. This may be done on a lathe, for example, using a Brush surface-analyzer pickup. The helical travel of the spot obtained from the two-phase generator coupled to the piston, and the motion of the positioning potentiometers, can then

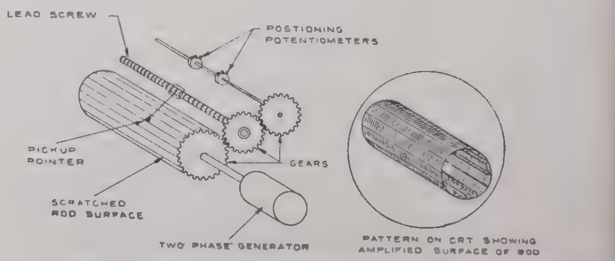
LEAD SCREW
POSTIONING POTENTIOMETERS
PICKUP POINTER
GEARS
SCRATCHED ROD SURFACE
TWO PHASE GENERATOR
PATTERN ON CRT SHOWING AMPLIFIED SURFACE OF ROD

Fig. 9—Application showing the representation of surface defects.

be modulated using a DuMont type 275A cathode-ray oscillograph in order to obtain an accurate but amplified visualization of the surface of the piston as seen in Fig. 9. If a representation in polar form is not desired, the oblique method described in the preceding sections can also be used, in which case a pattern similar to Fig. 8 is obtained.

6. *Complex Time Relations:* This method will also prove useful whenever there are complex time or phase relations to be plotted. These exist, for example, in the representation of electron bunching in velocity modulated tubes,[5] or in a composite sync signal such as is used for color television.

Numerous methods have been developed recently for the construction of equivalent circuits for three-dimensional objects.[6] Such equivalent circuits have been carried so far as to incorporate an equivalent circuit for the universe.[7] The operation of these circuits corresponds exactly to their equivalents. The results can best be shown in the three-dimensional projections proposed. Numerous other applications will doubtless occur for this method. It should be possible to extend this method to include functions of more than three variables.

[5] Klystron Technical Manual, Sperry Gyroscope Co., Inc., December, 1944.

[6] Gabriel Kron, "Equivalent circuits to represent the electromagnetic field equations," *Phys. Rev.* vol. 64, pp. 126–128; August, 1943.

[7] S. Austen Stigant, "Equivalent circuits for the electromagnetic field," *Beama Jour.*, pp. 412–416; December, 1944.

A Single-Control Variable-Frequency Impedance-Transforming Network*

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***Summary*—The basis of the variable-frequency transformer to be described is the familiar transmission-line stub matching section. Although an infinite number of structures may be found to produce the desired transformation at any one frequency, it is generally necessary to vary the lengths of the component lines to maintain matching when the frequency is changed.**

Mechanical complexities and electrical noise and losses in sliding contacts often make such methods undesirable. The particular solution to the stub matching problem described here is a structure which will maintain a perfect impedance match over a wide frequency range with the adjustment of a single reactance shunted across the load at the receiving end.

I. DESIGN FORMULAS

THE FOLLOWING symbols will be used:

Z_{01} = characteristic impedance of a line between the generator and the load
Z_{02} = characteristic impedance of a short-circuited stub line across the generator
$\theta_1 = 2\pi$ (length of line between the generator and the load)/(wavelength of applied energy)
$\theta_2 = 2\pi$ (length of stub line across the generator) /(wavelength of applied energy)
φ = desired voltage transformation
E_S = sending-end emf
I_S = sending-end current
E_R = receiving-end emf
I_R = receiving-end current
R_R = shunt load resistance
X_R = shunt load reactance
X_0 = value of X_R for perfect matching
R_g = internal resistance of generator

$$Y_{01}=\frac{1}{Z_{01}}, \quad Y_{02}=\frac{1}{Z_{02}}, \quad g_R=\frac{1}{R_R}, \quad g_g=\frac{1}{R_g},$$

$$ib_R = \frac{1}{jX_R}.$$

The formulas required for design are:

$$Z_{01} = \varphi R_g \qquad X_0 = \frac{\varphi^2 R_g}{\varphi - 1} \tan \theta_1$$

$$Z_{02} = \frac{\varphi}{\varphi - 1} R_g \qquad R_R = \varphi^2 R_g,\ \theta_2 = \theta_1.$$

The schematic diagram is shown in Fig. 1. The bandwidth characteristics will be discussed in Section III.

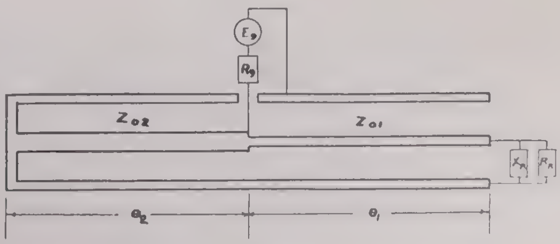

Fig. 1

* Decimal classification: R117.121. Original manuscript received by the Institute, December 4, 1947; revised manuscript received, May 17, 1948.

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II. THEORY OF OPERATION

The input conductance of a line is a function of the characteristic impedance of the line, the length of the line, the load conductance, the load susceptance, and the frequency. If the first three parameters are correctly chosen, only the load susceptance need be changed when the frequency is changed to keep the input conductance constant.

The input susceptance with this choice of parameters is always the negative of the susceptance of a stub of fixed dimensions. The derivation of the required relationships between these parameters is shown below.

The input admittance of the line connecting the generator to the load, g_R+jb_R, is given by

$$Y_{01}\frac{Y_R + jY_{01}\tan\theta_1}{Y_{01} + jY_R\tan\theta_1}.$$

The real component of this admittance is

$$g_R Y_{01}^2 \frac{1+\tan^2\theta_1}{(Y_{01} - b_R\tan\theta_1)^2 + g_R^2\tan^2\theta_1}$$

If b_R is selected as $(Y_{01}\pm g_R)\cot\theta_1$, the real component becomes Y_{01}^2/g_R. It may be noted that if $\theta=\pi/2$, then $b_R=0$, and we have as a special case the quarter-wave series transformer.

The imaginary component of the input admittance is

$$Y_{01}\frac{-Y_{01}b_R\tan^2\theta_1 + (Y_{01}^2 - b_R^2 - g_R^2)\tan\theta_1 + b_R Y_{01}}{(Y_{01} - b_R\tan\theta_1)^2 + g_R^2\tan^2\theta_1}.$$

When the value of b_R selected above is substituted in this expression, the imaginary admittance component is

$$-\frac{Y_{01}}{g_R}(g_R \pm Y_{01})\cot\theta_1.$$

This component may be tuned out by placing across the input terminals another susceptance of opposite sign which also varies as $\cot\theta_1$. This requirement is met by a shorted line of equal length. Because the shorted line has a negative susceptance, the sign of the previous expression must be positive. Then,

$$Y_{02} = \frac{Y_{01}}{g_R}(Y_{01} - g_R),\quad Y_{01} > g_R,\quad \theta_2 = \theta_1.$$

The total input admittance is, then,

$$\frac{Y_{01}^2}{g_R} = g_g.$$

Letting

$$g_g = \varphi^2 g_R,$$

then

$$Y_{01} = \frac{g_g}{\varphi},\qquad Y_{02} = \frac{\varphi - 1}{\varphi}g_g$$

and

$$b_0 = g_g\frac{\varphi - 1}{\varphi^2}\cot\theta_1.$$

III. RESPONSE AT ANY FREQUENCY

The equations

$$E_S = AE_R + BI_R$$

$$I_S = CE_R + DI_R$$

completely characterize the network. The coefficients may be found by writing similar equations for each network element and eliminating the intermediate emf's and currents. This is equivalent to the following matrix multiplication:

$$\left\|\begin{matrix} E_S \\ I_S \end{matrix}\right\| = \left\|\begin{matrix} 1 & 0 \\ \dfrac{-j(\rho-1)}{Z_{01}}\cot\theta_1 & 1 \end{matrix}\right\| \times \left\|\begin{matrix} \cos\theta_1 & jZ_{01}\sin\theta_1 \\ \dfrac{j\sin\theta_1}{Z_{01}} & \cos\theta_1 \end{matrix}\right\| \times \left\|\begin{matrix} 1 & 0 \\ jb_R & 1 \end{matrix}\right\| \times \left\|\begin{matrix} E_R \\ I_R \end{matrix}\right\|$$

Matrix of Stub Matrix of Series Line Matrix of b_R

$$\left\|\begin{matrix} E_S \\ I_S \end{matrix}\right\| = \left\|\begin{matrix} \cos\theta_1 - Z_{01}b_R\sin\theta_1 & jZ_{01}\sin\theta_1 \\ \dfrac{j}{Z_{01}}\left[Z_{01}\rho b_R\cos\theta_1 + \dfrac{1-\rho\cos^2\theta_1}{\sin\theta_1}\right] & \rho\cos\theta_1 \end{matrix}\right\| \times \left\|\begin{matrix} E_R \\ I_R \end{matrix}\right\|,$$

or

$$A = \cos\theta_1 - Z_{01}b_R\sin\theta_1$$

$$B = jZ_{01}\sin\theta_1$$

$$C = \frac{j}{Z_{01}}\left[Z_{01}\rho b_R\cos\theta_1 + \frac{1-\varphi\cos^2\theta_1}{\sin\theta_1}\right]$$

$$D = \varphi\cos\theta_1.$$

It has been shown that the mismatch ratio η, which is the ratio of the power delivered to the load with perfect matching to the power delivered to the load under actual conditions, is given for any four-terminal network by

$$\eta = \frac{AR_R + B + CR_gR_R + DR_g}{4R_RR_g}.$$

(For the sake of completeness, the four-terminal mismatch ratio formula is derived below:

$$\begin{aligned} E_S &= AE_R + BI_R \\ I_S &= CE_R + DI_R \end{aligned} \quad \text{or} \quad \begin{aligned} E_S &= (AR_R + B)I_R \\ I_S &= (CR_R + D)I_R. \end{aligned}$$

or the open-circuit generator emf E_g is then

$$E_S + I_SR_g = I_R(AR_R + B + CR_RR_g + DR_g)$$

and the maximum possible power delivered is

$$\frac{E_g^2}{4R_g} = I_R^2 \frac{|AR_R + B + CR_RR_g + DR_g|^2}{4R_g}.$$

The actual power delivered is I^2R_R, and η is the ratio defined above.)

For the network considered here,

$$\eta = \frac{\left| R_R(\cos\theta_1 - Z_{01}b_R \sin\theta_1) + R_g\varphi\cos\theta_1 + jZ_{01}\sin\theta_1 + j\frac{R_gR_R}{Z_{01}}\left(Z_{01}\varphi b_R\cos\theta_1 + \frac{1 - \varphi\cos^2\theta_1}{\sin\theta_1}\right)\right|}{4R_RR_g}.$$

Since, by initial choice, $R_R = \rho^2R_g$ and $Z_{01} = \rho R_g$, the formula simplifies to

$$\eta = 1 + \frac{R_R^2}{4}\left(b_R - \frac{\varphi - 1}{R_R}\cot\theta_1\right)^2.$$

An equivalent circuit for which the formula holds is shown in Fig. 2. To show the equivalence, consider a potential φE_g impressed across the load in series with $\varphi^2R_g = R_R$. The maximum possible load power will then

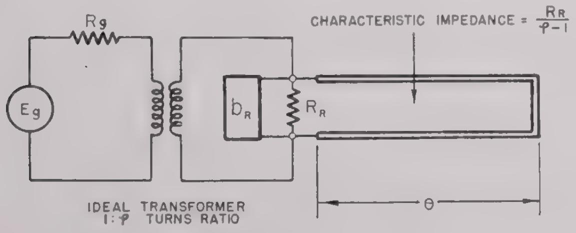

Fig. 2

be $\varphi^2E_g^2/4R_R$. If ξ_R represents the reactance of the parallel circuit composed of the transmission line and X_R, the actual load power will be

$$\frac{\varphi^2E_g^2}{R_R}\left|\frac{\dfrac{j\xi_RR_R}{j\xi_R + R_R}}{R + \dfrac{j\xi_RR_R}{j\xi_R + R_R}}\right|^2$$

or

$$\frac{\varphi^2E_g^2}{R_R} \frac{1}{4 + \left(\dfrac{R_R}{\xi_R}\right)^2}$$

$$\eta = \frac{\varphi^2E_g^2}{4R_R}\frac{R_R}{\varphi^2E_g^2}\left(4 + \frac{R_R^2}{\xi_R^2}\right) = 1 + \frac{R_R^2}{4}\frac{1}{\xi_R^2},$$

and, by definition,

$$\frac{1}{\xi_R^2} = \left(b_R - \frac{\varphi - 1}{R_R}\cot\theta_1\right)^2.$$

From the above discussion it may be seen that the circuit parameters which may be varied to obtain diverse frequency characteristics are the length of the line and the configuration of b_R.

IV. A PRACTICAL APPLICATION

Transformers of this type were built to match antenna cables to mixers of color television receivers operating over the range of 480 to 920 Mc. A parallel-tuned circuit operating above resonance was used to obtain the tuning susceptance. The capacitor was ganged to the local-oscillator shaft, and varied the susceptance as the frequency changed. Tracking was accomplished by sectionalizing the stator and varying the spacing of each section to the rotor to obtain the correct capacitance curve. Because the desired transformation ratio was 2:1, the structure became simply a uniform transmission line of length 2θ fed at the center. Fig. 3 is a photograph of the transformer detached from the oscillator.

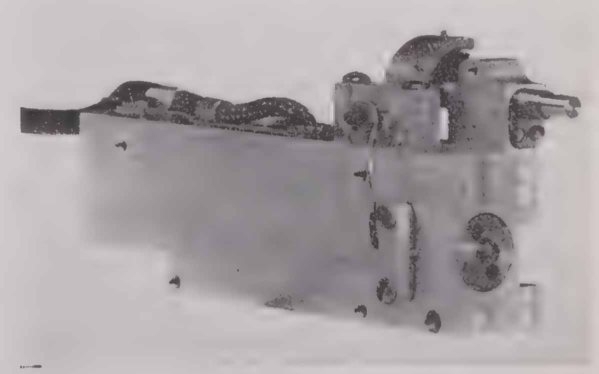

Fig. 3

Phase Difference Between the Fields of Two Vertically Spaced Antennas*

E. W. HAMLIN†, ASSOCIATE, IRE, AND A. W. STRAITON‡, MEMBER, IRE

Summary—**This paper discusses the phase differences between the fields of two vertically spaced antennas as a function of transmitter height, receiver height, and distance between transmitter and receiver. The results are applicable to microwave propagation within the line-of-sight region when a direct wave and a ground-reflected wave are present, and have been useful in interpreting phase-difference measurements made by the Electrical Engineering Research Laboratory of the University of Texas.**[1,2,5]

INTRODUCTION

IN THE PAST two years, the University of Texas, investigating the angle of arrival of radio waves under a contract with the Office of Naval Research, has made many measurements[1,2] of phase difference between signals received at two identical antennas spaced a number of wavelengths apart. One of the primary objects of the study was to determine how fast the angle of arrival might change. It was this consideration which prompted the decision to use the phase-difference method, and equipment[3] was designed and put in operation which could record changes in phase of a few degrees taking place in a second. The work has been done entirely at a wavelength of 3.2 cm.

Microwave angle-of-arrival measurements by the maximum signal strength method have been reported by Sharpless.[4]

To measure horizontal angle, the two antennas are placed at the same height above the ground, but spaced a known distance apart horizontally. For vertical-angle measurements, they are spaced vertically one above the other. In either case, if only one ray is received at the two antennas, the angle of arrival of the ray is directly proportional to the difference in phase of the signal received in the two antennas.

Even in making horizontal measurements,[2] however, the effect of the ground-reflected component is noticeable. In making vertical phase-difference measurements, the effect of the reflected wave, even with low values of reflection coefficient, must be taken into account. A reflected wave only 20 per cent as large as the direct can change the measured phase difference by ±20° from that for the direct wave alone. Since the resolution of the equipment is about ±2°, it is essential to investigate this effect mathematically. The results of the analysis presented in this paper have proved very useful in the study of field-measured phase-difference data.[1,2,5]

The present paper investigates this effect under the simplest conditions. Two identical receiving antennas are spaced vertically in a plane perpendicular to the direction of propagation. Mutual coupling between the antennas is assumed to be negligible. The earth is assumed flat and two rays only are considered, a direct wave and one reflected from the ground. The reflected wave is assumed to suffer a complete phase reversal on reflection. For the horizontal polarization which has been used, and the high frequency at which the measurements were made, this latter assumption is very nearly true. Effects similar to those to be presented here may be expected under practical field conditions.

SYMBOLS AND DEFINITIONS

h_1 and h_2 = height of transmitting and receiving antennas, respectively
h_2^0 = average height of two receiving antennas
d = horizontal distance between transmitter and receiver
d_1 and d_2 = distance from reflecting point to transmitter and receiver, respectively
λ = wavelength
L_D and L_R = length of path of direct and reflected rays, respectively
ϕ, ϕ_D and ϕ_R = phase of resultance, direct and reflected rays with reference to the transmitter
θ, θ_D and θ_R = phase difference between signal received at upper and lower horns for resultant, direct, and reflected waves, respectively
$\Delta\theta_D$ = deviation in phase difference from that of direct wave only $= \theta - \theta_D$
$\Delta\phi$ = deviation in phase from that of direct wave only $= \phi - \phi_D$
K = magnitude of reflected wave with respect to the direct

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[2] A. W. Straiton and J. R. Gerhardt, "Results of horizontal microwave angle-of-arrival measurements by phase-difference method," PROC. I.R.E., vol. 36, pp. 916–922; July, 1948.

[3] F. E. Brooks, Jr. and C. W. Tolbert, "Equipment for Measuring Angle-of-Arrival by the Phase Difference Method," University of Texas, Electrical Engineering Research Laboratory, Report No. 2, May, 1946.

[4] W. M. Sharpless, "Measurement of the angle-of-arrival of microwaves," PROC. I.R.E., vol. 34, pp. 837–845; November, 1946.

[5] E. W. Hamlin and W. E. Gordon, "Comparison of calculated and measured phase difference at 3.2 centimeters wave length," PROC. I.R.E., vol. 36, pp. 1218–1224; October, 1948.

V_C and V = field strength of resultant and direct waves, respectively
Δh_2 = spacing between receiving antennas
Δh_1 = difference between two transmitter heights
Δh_2^0 = difference between two receiver heights
α = angle of arrival
$n = \dfrac{2h_1h_2}{\lambda d}$
Δn = difference between two values of n.

Single-primed values refer to the lower receiving antenna. Double-primed values refer to the upper receiving antenna.

PHASE RELATIONS RELATIVE TO THE TRANSMITTER

The geometry is shown in Fig. 1. The angle of incidence equals the angle of reflection. The distance between the transmitter and receiver is large compared to the heights. Using images, and the usual approximations (neglecting terms higher than the square in the binomial expansion of a square root), the path lengths of the direct and reflected waves become

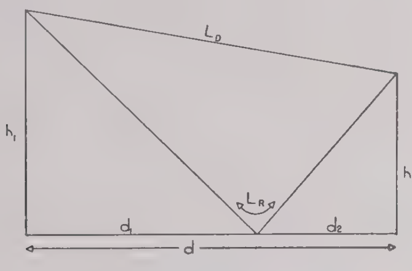

Fig. 1—Distance relationships.

$$L_D = d + \frac{(h_1 - h_2)^2}{2d} \tag{1}$$

and

$$L_R = d + \frac{(h_1 + h_2)^2}{2d}. \tag{2}$$

The path difference will be

$$L_R - L_D = 2h_1h_2/d. \tag{3}$$

The direct wave will lag the transmitter in phase by

$$\phi_D = \frac{2\pi}{\lambda}\left(d + \frac{(h_1 - h_2)^2}{2d}\right). \tag{4}$$

This approximation makes ϕ_D parabolic with respect to the transmitter height h_1, or receiver height h_2. The phase lag decreases with increasing h_1 or h_2 until $h_1 = h_2$, and then increases.

Similarly, the reflected wave lags the transmitter by

$$\phi_R = \frac{2\pi}{\lambda}\left(d + \frac{(h_1 + h_2)^2}{2d}\right) - \pi, \tag{5}$$

assuming that the phase is advanced π radians on reflection. For horizontal polarization, and any ordinary ground constants, this will be true at microwave frequencies. ϕ_R is also parabolic when plotted versus h_1 or h_2. If h_1 or h_2 are plotted vertically, the axis of the parabola is horizontal and below the reflecting surface by h_1 or h_2, whichever is constant. For positive h_1 or h_2 (transmitter and receiver above ground), ϕ_R increases with increasing h_1 or h_2.

The angle by which the reflected wave lags the direct is

$$\phi_R - \phi_D = \frac{4\pi h_1 h_2}{\lambda d} - \pi = (2n - 1)\pi. \tag{6}$$

Thus, with transmitter or receiver at the level of the reflecting plane, the direct and reflected waves are 180° out of phase.

The angle by which the combined signal lags the transmitter depends upon the relative magnitude of the direct and reflected components. If the field strength of the direct wave is V, and that of the reflected wave KV, the vector field strength of the combined wave will be

$$V_C\underline{/\phi} = V\underline{/\phi_D} + KV\underline{/\phi_R}. \tag{7}$$

The space orientation of the two components is the same for horizontal polarization. Equation (7) may be written

$$V_C\underline{/\phi_D + \Delta\phi} = V\underline{/\phi_D}(1 + K\underline{/(2n - 1)\pi})$$

or

$$V_C\underline{/\Delta\phi} = V(1 - K\underline{/2n\pi}) \tag{8}$$

where $\Delta\phi$ is the deviation in phase from that due to the direct wave alone.

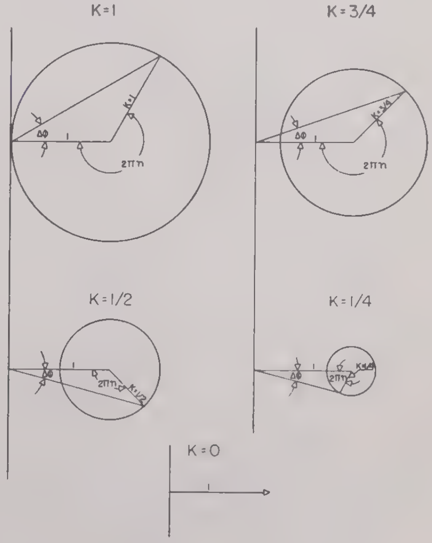

Fig. 2—Loci of $V/\Delta\phi$.

As n varies, the locus of $V_C\underline{/\Delta\phi}$ will be a circle with its center at $(V, 0)$ and radius equal to KV. For $n = 0$, the vector KV falls horizontally to the left. As n increases, the rotating vector KV turns counterclockwise, making a complete revolution as n goes from 0 to 1. The loci of V_C for several values of K are shown in Fig. 2.

From (8),

$$\Delta\phi = \tan^{-1}\left[\frac{-K \sin 2\pi n}{1 - K \cos 2\pi n}\right] \tag{9}$$

and the combined wave lags the transmitter by $\phi+\Delta\phi$. The relation (9) is shown graphically in Fig. 3 for several values of K, with ϕ plotted as a function of h_1 or h_2.

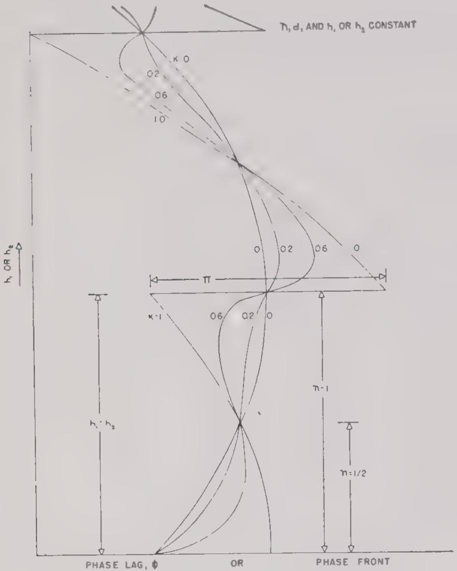

Fig. 3—Phase fronts.

The curvature of the parabola representing the relationship for $K=1$ is greatly exaggerated for large distances, but is used for the sake of illustration. The graph of Fig. 3 also represents the phase front.

$\Delta\phi$ as a function of n is shown in Fig. 4 for several values of K. Maximum and minimum values of $\Delta\phi$ occur when $\cos 2\pi n = K$, and are $\pm\sin^{-1} K$.

Phase Difference Between Two Antennas at Different Heights

The phase difference between two identical receiving antennas, one vertically above the other in a plane perpendicular to the direction of propagation, will be the difference between the phases of the signals at each antenna relative to the transmitter. Each will be of the form $\phi_D+\Delta\phi$, from (4) and (9). Let the height of the upper antenna be h_2'', and of the lower, h_2'; then $h_2''=h_2'+\Delta h_2$ where Δh_2 is the vertical spacing.

For a direct wave alone, the angle by which the lower antenna lags the upper in phase is $\theta_D=\phi_D'-\phi_D''$ where the single prime refers to the lower antenna, and the double prime to the upper. θ_D may be written

$$\theta_D = \frac{2\pi}{\lambda d}(h_1 - h_2^0)\Delta h_2 \tag{10}$$

where h_2^0 is the average height of the receiving antennas

A graph of θ_D versus transmitter height will be straight line with a slope $2\pi\Delta h_2/\lambda d$. The phase lag of th

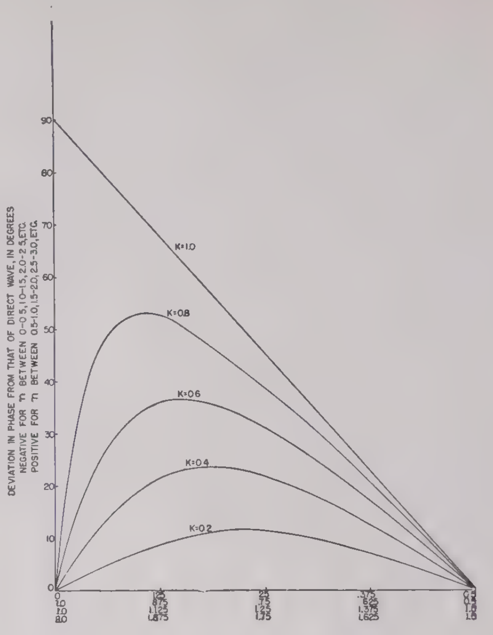

Fig. 4—$\Delta\phi$ as a function of 1.

lower antenna continually increases as the transmitte is raised. If the receiving antennas are raised together keeping their spacing constant, the slope of the line i negative but of the same magnitude.

The angle of arrival of the direct wave alone, at the average height of the receiving antennas, is obtaine from (10). This angle is

$$\alpha = \tan^{-1}\frac{h_1 - h_2^0}{d} \cong \frac{h_1 - h_2^0}{d} \cong \frac{\theta_D\lambda}{2\pi\Delta h_2}$$

when $d \gg h_1 - h_2^0$. (11

Positive α indicates angles of arrival above horizontal The resolution of the equipment is determined by the smallest θ_D which may be measured, and the receiving antenna spacing in wavelengths. At 3.2-cm wavelength with antennas spaced 10 feet apart, the phase angle θ_D is 600 times the space angle of arrival. Since θ_D is ambiguous in intervals of 360°, the space angle is ambiguous in intervals of 0.6°.

For a wave containing both direct and reflected components, the phase lag of the lower antenna behind the upper is $\theta=\theta_D+\Delta\theta$ where $\Delta\theta=\Delta\phi'-\Delta\phi''$. This is

$$\theta = \frac{2\pi}{\lambda d}(h_1 - h_2^0)\Delta h_2 + \tan^{-1}\left[\frac{-K \sin 2\pi n'}{1 - K \cos 2\pi n'}\right] - \tan^{-1}\left[\frac{-K \sin 2\pi n''}{1 - K \cos 2\pi n''}\right] \quad (12$$

where the primes refer to the respective antennas, as above.

VARIATION OF PHASE DIFFERENCE OF THE RESULTANT WAVE WITH TRANSMITTER HEIGHT

As the transmitter height is increased, the first term in (12), θ_D, increases linearly, and the second two terms which make up $\Delta\theta$ will be alternately plus and minus (Fig. 5). The magnitude of these variations starts at zero with the transmitter at the reflecting surface ($h_1=0$), increasing to a maximum and returning to zero when

$$n'' = n' + 1.$$

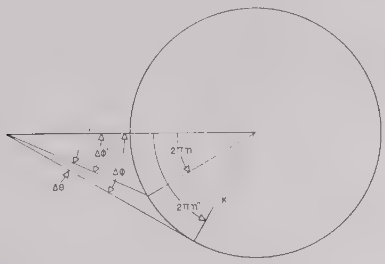

Fig. 5.—Deviation in phase from that of the direct wave determined from loci diagram.

Starting from any value of h_1, a complete set of values of $\Delta\theta$ will be run through when the change in n'', $\Delta n''$ exceeds the change in n', $\Delta n'$ by one, or when h_1 changes by

$$\Delta h_1 = \frac{\lambda d}{2\Delta h_2}. \tag{13}$$

This depends only upon the spacing between receiving antennas, the wavelength, and the distance, and is independent of the height of either the transmitter or the receiver. A plot of θ_D versus h_1 will show a straight line with height, about which θ varies, the variations repeating at intervals Δh_1.

The variation $\Delta\theta$ in phase from that of the direct wave alone will be zero at transmitter heights at which

$$\frac{\sin 2\pi n'}{1 - K\cos 2\pi n'} = \frac{\sin 2\pi n''}{1 - K\cos 2\pi n''}, \tag{14}$$

from which it follows that

$$\sin\frac{2\pi h_1\Delta h_2}{\lambda d}\left(\cos\frac{4\pi h_1 h_2^0}{\lambda d} - K\cos\frac{2\pi h_1\Delta h_2}{\lambda d}\right) = 0. \tag{15}$$

This equation is satisfied if either factor is zero.

If the first factor is zero,

$$n'' - n' = N \tag{16}$$

where $N=1, 2, 3$, etc., or

$$\frac{2h_1\Delta h_2}{\lambda d} = N, \tag{17}$$

corresponding to (13) above with the first zero at ground level.

The second factor taken equal to zero results in the condition

$$\tan\pi n' \tan\pi n'' = \frac{1-K}{1+K}. \tag{18}$$

Curves showing the variations of θ with h_1 for typical cases are shown in Figs. 6 and 7 for different values of K. In each case only one interval of height corresponding to (17) is shown. The other zeros of $\Delta\theta$ are due to (18).

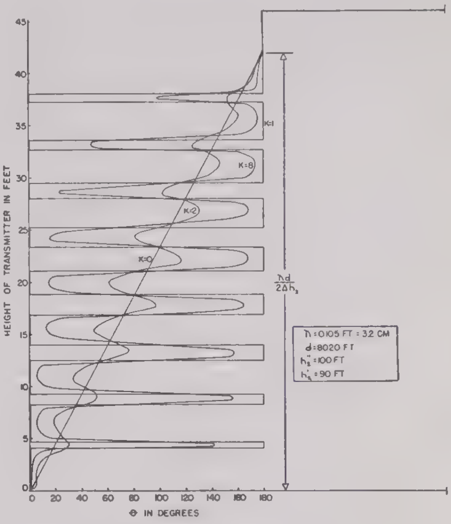

Fig. 6—Variation of phase difference with transmitter height, example No. 1.

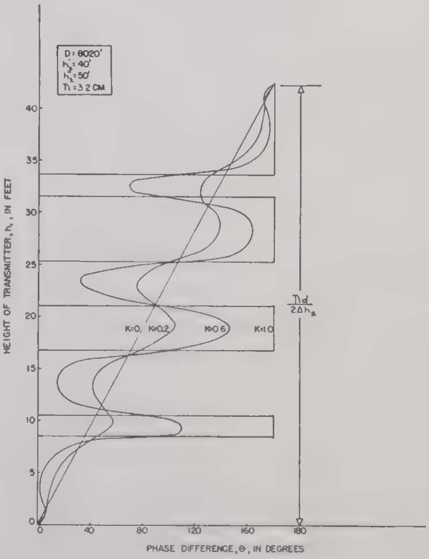

Fig. 7—Variation of phase difference with transmitter height, example No. 2.

VARIATION OF PHASE DIFFERENCE OF THE RESULTANT WAVE WITH RECEIVER HEIGHT

If the receiver height h_2^0, is increased, the general slope of the curves of θ versus h_2^0 will be opposite to that occurring when the transmitter is raised. Also, n'' and n' increase with h_2^0 at exactly the same rate. Hence, phase-difference versus receiver-height curves repeat at intervals

$$\Delta h_2^0 = \frac{\lambda d}{2h_1}, \tag{19}$$

which do not depend upon receiver height or spacing of receiving antennas, but only upon wavelength, distance, and transmitter height.

The zeros of $\Delta\theta$ are still given by (14). The first factor of (15) does not vary with h_2^0, and for an abritrary transmitter height and antenna spacing, it will not be zero. Also, the second term of the second factor does not depend upon h_2^0, so that equating this factor to zero gives only two values of h_2^0 at which $\Delta\theta = 0$ in each repeating interval. An example of the type of curve to be expected is shown in Fig. 8, in which the constants have been chosen so as to make $\Delta\theta$ symmetrical about the θ_D line. h_2^0 must, of course, be greater than half Δh_2.

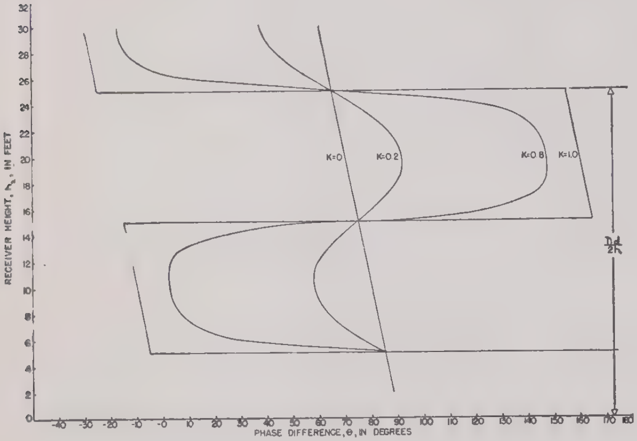

Fig. 8—Variation of phase difference with receiving height.

If transmitter height, or antenna spacing, or both, is chosen so as to make the first factor of (15) zero, the phase difference is always that of the direct wave alone. Thus, when

$$h_1 = \frac{N\lambda d}{2\Delta h_2} \qquad N = 1, 2, 3, \text{etc.}, \tag{20}$$

the last two terms in (12) cancel for all receiver heights. The plot of θ versus h_2^0 is just a straight line. On the other hand, if h_1 is chosen at midway between the values indicated by (20), large variations from θ_D occur, as shown in Fig. 8.

SPECIAL CONDITIONS WHEN $K=1$

For the special case, $K=1$, $\Delta\phi$ in (9) becomes

$$\Delta\phi = \tan^{-1}\frac{-\sin 2\pi n}{1 - \cos 2\pi n} \tag{9}$$

$$\Delta\phi = \pi n - \frac{\pi}{2} \quad \text{for} \quad 0 < n < 1$$

$$\Delta\phi = \pi n - \frac{3\pi}{2} \quad \text{for} \quad 1 < n < 2$$

and, in general,

$$\Delta\phi = \pi n - \frac{(2N-1)}{2}\pi \quad \text{for} \quad (N-1) < n < N. \tag{21}$$

Then the deviation in phase difference from that of the direct wave alone $\Delta\theta$ is given by

$$\begin{aligned}\Delta\theta &= -\frac{2\pi h_1 \Delta h_2}{\lambda d} && \text{for} \quad 0 < n'' < 1 \\ &= -\frac{2\pi h_1 \Delta h_2}{\lambda d} + \pi && \text{for} \quad 1 < n'' < 2 \\ & && \text{and} \quad 0 < n' < 1 \\ &= -\frac{2\pi h_1 \Delta h_2}{\lambda d} && \text{for} \quad 1 < n'' < 2 \\ & && \text{and} \quad 1 < n' < 2.\end{aligned} \tag{22}$$

But θ_D is given by (10) as

$$\theta_D = \frac{2\pi \Delta h_2}{\lambda d}[h_1 - h_2^0].$$

Adding (10) and (22), it is found that

$$\begin{aligned}\theta &= -\frac{2\pi h_2^0 \Delta h_2}{\lambda d} && \text{for} \quad 0 < n'' < 1 \\ &= -\frac{2\pi h_2^0 \Delta h_2}{\lambda d} && \text{for} \quad 1 < n'' < 2 \\ & && \text{and} \quad 0 < n' < 1 \\ &= -\frac{2\pi h_2^0 \Delta h_2}{\lambda d} && \text{for} \quad 1 < n'' < 2 \\ & && \text{and} \quad 1 < n' < 2.\end{aligned} \tag{23}$$

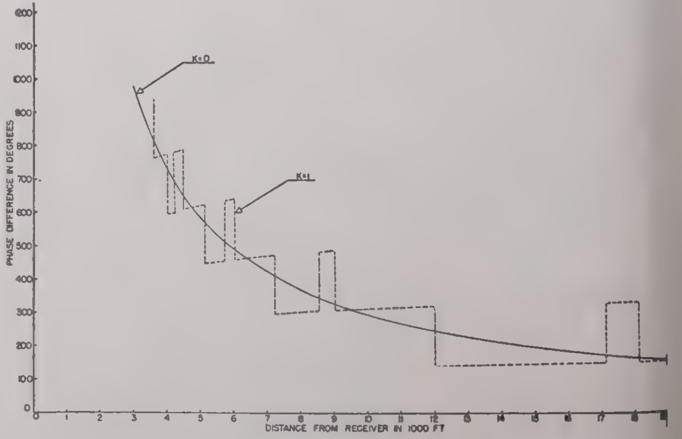

Fig. 9—Variation of phase difference with distance.

This shows θ to be equal to $-2\pi h_2^0\Delta h_2/\lambda d$, or this value increased by π in the range $0>n''>2$. If h_1 is the variable, these values are constants. As h_1 is increased from zero, θ will jump from one of these values to the other when either n'' or n' passes through an integer value, as shown by the $K=1$ lines in Figs. 6 and 7. This continues until n'' exceeds n' by one, corresponding to the condition of (17). From this point, the alternate values of θ will be $-2\pi h_2^0\Delta h_2/\lambda d+\pi$, and $-2\pi h_2^0\Delta h_2/\lambda d+2\pi$ until n'' exceeds n' by 2.

If h_2^0 is the variable, $-2\pi h_2^0\Delta h_2/\lambda d$ is not a constant, but a line with the same slope as θ_D. Also n'' is larger than n' at all times by a constant value $2h_1\Delta h_2/\lambda d$. Again, each time n'' or n' passes through an integer value a jump of π occurs, but because of the constant difference the jumps are spaced at regularly repeating intervals. This is shown by the $K=1$ lines in Fig. 8. It should be pointed out that variations about the line θ_D are not necessarily symmetrical, although Fig. 8 is drawn for such a case.

VARIATION WITH DISTANCE AND WAVELENGTH

If the distance or wavelength is variable, the variations are similar to those for variable transmitter height, when plotted against inverse distance or frequency. A typical example of phase-difference variations plotted directly against distance is shown in Fig. 9.

Contributors to Waves and Electrons Section

ANDREW BARK

Andrew Bark (M'47) was born in Seattle, Wash., on December 2, 1919. He was graduated from the University of Detroit in 1942, with the B.E.E. degree, after working for three years at the Detroit Edison Company Research Laboratories under a co-operative system with the University of Detroit. After graduation, he went to the Radio Research Laboratory, at Harvard University, as a research associate. He was a special representative of the Office of Scientific Research and Development in England.

Mr. Bark joined the Columbia Broadcasting System, Inc., in New York, N. Y., in 1944. His work was initially concerned with radar countermeasures; at present he is engaged in research on color television and an instantaneous audience-measurement system.

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CARL BERKLEY

Carl Berkley (A'45) was born in New York, N. Y., on February 19, 1917. He attended the College of the City of New York. He was a motion-picture cameraman at the Browning Studios from 1936 to 1938, a teacher of photography in the New York public schools from 1938 to 1939, and a technician engaged in biological research and exhibit work in the Laboratory of Experimental Biology at the American Museum of Natural History from 1939 to 1941. In 1941, he was employed at the Agfa Ansco Company at Binghamton, N. Y., in development work on multilayer color films.

Since 1942 Mr. Berkley has been engaged at the Allen B. DuMont Laboratories in engineering and application work on cathode-ray tubes and instruments. In 1947, he assumed charge of the applications section of the Instrument Division of that Company.

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L. B. HALLMAN, JR.

Ludlow B. Hallman, Jr., (J'27–A'29–SM'44) was born in Sneads, Fla., on July 21, 1907. He studied electrical engineering at the Alabama Polytechnic Institute in Auburn, Ala., from 1925 to 1929. During his undergraduate career he served part time as an instructor in radio at the Institute, and as an engineer for broadcast station WAPI. He received the B.S. degree in electrical engineering from the Alabama Polytechnic Institute in 1929, and the E.E. degree in 1934.

Shortly after graduation, Mr. Hallman became associated with the Montgomery Broadcasting Co., at Montgomery, Ala., as chief engineer of station WSFA. He continued to work in the field of broadcast station engineering until 1936, when he accepted a position in the Aircraft Radio Laboratories at Wright Field, Ohio. Since then he has been associated with various projects involving the development, procurement, and testing of special electronic equipment for the U. S. Air Forces. At present, he is assistant chief of the Communication and Navigation Laboratory, Electronic Subdivision, at Wright Field.

Mr. Hallman served as Chairman of the Dayton IRE Section during 1945, and is now Chairman of the Headquarters Relations Committee of this Section. He holds membership in the honorary fraternities of Eta Kappa Nu, Tau Beta Pi, and Phi Kappa Phi.

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For a photograph and obituary of the late E. W. HAMLIN, see page 887 of the July, 1948, issue of the PROCEEDINGS OF THE I.R.E.

WILLIAM E. SHOUPP

William E. Shoupp (SM'45) was born in Troy, Ohio. He was graduated from Miami University in Oxford, Ohio, in 1931 with the degree of bachelor of science in physics, and for the next six years served as graduate assistant and instructor in physics in the University of Illinois. Here he was awarded the master of arts degree in 1933 and the doctor of philosophy in physics in 1937. In 1938 he joined the Westinghouse Research Laboratories as a Westinghouse Research Fellow, and three years later was named a research engineer. He was appointed to his present position as manager of the electronics department at the Laboratories in 1943, a responsibility which later was broadened to include all nuclear physics work being carried on in the Westinghouse Research Laboratories.

During the war years Dr. Shoupp was in charge of all Westinghouse radar research and development, which included the T-R tube, the resnatron, standard frequency cavity, the magnetron, and the crystal rectifier. In the field of nuclear physics Dr. Shoupp has been associated with the discovery of photofission (the fission of uranium by gamma radiation) and with the discovery of the threshold of fast neutron fission of uranium and thorium, having published numerous articles on nuclear reactions and nuclear properties.

Dr. Shoupp is a Fellow of the American Physical Society, the Pittsburgh Physical Society, and a member of the American Institute of Electrical Engineers. He is a member of Sigma Xi and Phi Beta Kappa.

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For a photograph and biography of A. W. STRAITON, see page 931 of the July, 1948, issue of the PROCEEDINGS OF THE I.R.E.

Abstracts and References

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ACOUSTICS AND AUDIO FREQUENCIES

534.21 **2997**

Directional Characteristic of a Cylindrical Radiator with a Coaxial Conical Reflector—G. Bacchi. (*Alta Frequenza*, vol. 17, pp. 74–78; April, 1948. In Italian with English, French, and German summaries.) Magnetostriction oscillators of the above type, adapted for radial vibration, have radiation patterns with an absolute maximum along the axis. The wavelength is of the same order as the dimensions of the cylinder. The radiation pattern is calculated. With a 45° cone, the characteristic is represented by the integral of Bessel's function of zero order.

534.242 **2998**

Formula Involving the Shape for Calculating the Resonance Frequency of Helmholtz Resonators—D. Chervet and J. Henry. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1891–1893; June 7, 1948.) Rayleigh's formula was established on the assumptions that the pressure inside the resonator is constant and that the resonator dimensions are small compared with the resonance wavelength. Measurements show that the pressure varies from point to point according to an exponential law, the maximum pressure being at the bottom of the resonator. From this a correction formula is derived which is not easy to use and can be replaced by an empirical formula involving simply the product of the resonator length L and the resonance frequency f_0 given by Rayleigh's formula. Experimental results for resonators of various shapes are tabulated, together with the frequencies calculated from Rayleigh's formula and the two correction formulas.

534.321.9 **2999**

Distortion of Progressive Ultrasonic Waves—J. C. Hubbard, J. A. Fitzpatrick, B. T. Kankovsky, and W. J. Thaler. (*Phys. Rev.*, vol. 74, pp. 107–108; July 1, 1948.) Spark shadow photographs of ultrasonic waves in air, water, glycerine, and CCl_4 show definite changes of waveform into a type with steeper fronts and increased harmonic content.

534.321.9:621.391.63 **3000**

Distortion in Light Modulation by an Ultrasonic Cell—D. Sette. (*Alta Frequenza*, vol. 17, pp. 51–68; April, 1948. In Italian with English, French, and German summaries.) Description of an 8-Mc cell similar to that of Giacomini (1847 of August). Frequency distortion in a modulated light beam transmitted through the cell is small even for comparatively high modulation frequencies. The low distortion and the high modulation factor possible are particular advantages of such a system.

53.321.9.001.8:614.8 **3001**

Notes on Using High-Power Ultrasonics—(*See* 3195.)

534.75 **3002**

Audibility of High-Frequency Sounds—V. Gavreau. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 2053–2054; June 21, 1948.) It is found that sounds of frequencies from 17.5 kc to 26 kc are perfectly audible when sufficiently intense. When the intensity of such sounds is steadily increased, one or more sudden apparent changes of pitch, of about an octivae, are observed. These apparent changes of pitch may be due to abrupt changes in the order of the harmonic response of the resonators of the ear. Magnetostriction oscillators were used and gave sound powers up to 5 w.

534.756.1 **3003**

Phase Memory of the Ear: A Proof of the Resonance Hypothesis—R. J. Pumphrey and T. Gold. (*Nature* (London), vol. 161, p. 640; April 24, 1948.) Two alternative trains of sine-wave pulses are used. Each pulse contains n cycles, the pulse separation being m cycles, where m and n are both integers. In one train, the phase of all pulses is the same, while in the other the phase of alternate pulses is reversed. The ear can differentiate between the two trains. It follows that the value of Q for the resonators of the ear must be at least 100 and is probably considerably higher. See also 8 of February.

534.83 **3004**

Acoustic Materials—(*Electronics*, Buyers' Guide Issue, vol. 21, pp. M2–M3; June, 1948.) Noise reduction coefficients of various sound-absorbing materials are tabulated and compared with those of ordinary building materials. Mountings used in sound absorption tests are discussed briefly.

534.839 **3005**

Methods for the Study of Noise—A. Moles. (*Radio Franç.*, pp. 9–15; June, 1948.) Subjective and objective methods are discussed, the principal characteristics of various types of microphone are considered and a description of the General Radio decibel meter is given. Harmonic analyzers are also considered briefly.

53.851:621.395.813 **3006**

Measuring Wow—U. R. Furst. (*FM and Telev.*, vol. 8, pp. 30, 50; May, 1948.) Discussion of methods of measurement, and description of a commercial type of meter.

534.861.1:621.316.345:621.396.664 **3007**

Modern Design Features of CBS Studio Audio Facilities—Monroe and Palmquist. (*See* 3241.)

534.861.1:621.396.712.3 **3008**

Speech-Input Equipment for New Oslo Broadcasting House—E. Julsrud and G. Wieder. (*Elec. Commun.*, vol. 25, pp. 21–29; March, 1948.) An illustrated description, giving details of the facilities available. Easy, flexible, and reliable operation is ensured by extensive use of automatic switching.

621.395.623.7.015.3 **3009**

Study of Loudspeakers in the Transient Regime—G. Guyot. (*Rev. Gén. Élec.*, vol. 57, pp. 245–253; June, 1948.) Discussion of the response of loudspeakers to steady tones, with methods of obtaining the corresponding curves, and a detailed account of test methods and results for square-shape sine-wave signals and for pulse signals. Preliminary results indicate a correlation between the quality appreciated by the ear and the duration of the transient signal. For a loudspeaker 21 cm in diameter, signal quality was found to fall off if the duration of the pulse signal was below about 2.7 ms. Discussion of the various methods of testing loudspeakers shows that transient tests cannot replace ordinary methods completely, but that they furnish valuable information as to loudspeaker quality.

621.395.625.3 **3010**

Two-Channel Two-Way-Drive Magnetic Tape Recorder—R. E. Zenner and R. B. Vaile, Jr. (*Audio Eng.*, vol. 32, pp. 11–15; April, 1948.) Designed for good performance at low tape speed.

621.395.625.3 **3011**

Test Characteristics of Recording Wire—Carter and Koontz. (*See* 3149.)

621.395.625.6:621.317.75.015.3 **3012**

Sweeping Device for the Display of Transient Phenomena and Nonlinear Distortion—Meyer-Eppler. (*See* 3183.)

ANTENNAS AND TRANSMISSION LINES

621.315 3013

Transmission Line Theory Simplified—W. Redmayne. (*Distrib. Elec.*, vol. 20, pp. 346–348, 350; April, 1948.) The general equations for voltage and current at any point of a dc transmission system are derived without using differential equations. Both loaded and unloaded lines are considered. The equations can be easily adapted to the case of ac transmission.

621.315.2.017.71 3014

Heating of Radio-Frequency Cables—W. W. Macalpine. (*Elec. Commun.*, vol. 25, pp. 84–99; March, 1948.) Discussion with particular reference to solid-dielectric coaxial cables; only the simplest physical or mathematical assumptions are made.

621.315.23:620.197.6 3015

Rubber Thermoplastic Jacket for Buried Cable—C. V. Lundberg. (*Bell Lab. Rec.*, vol. 26, pp. 148–151; April, 1948.) Protection of the lead casing of cables against corrosion is secured by two layers of a material made from reclaimed rubber, clay, resin, paraffin wax, and mineral rubber. A fabric tape, corrugated Cu sheath and bitumen layer are applied outside the rubber.

621.392.029.64 3016

Attenuation of the H_{10} Wave in a Rectangular Waveguide—N. N. Malov. (*Zh. Tekh. Fiz.*, vol. 18, pp. 417–420; April, 1948. In Russian.) Discussion of a method based on an examination of the multiple reflection of the transverse wave from the walls of the waveguide. It is shown that the H_{m0} and H_{0n} types of wave cannot be regarded as particular cases of the H_{mn} type with m or n zero.

621.392.029.64 3017

The Excitation of a Rectangular Waveguide through a Slot—I. I. Vol'man. (*Radiotekhnika* (Moscow), vol. 3, pp. 49–55; May and June, 1948. In Russian.) Methods are indicated for calculating the field produced between two parallel planes by energy supplied through an aperture. The results obtained can be applied in the theory of rectangular waveguides.

621.392.029.64 3018

Effect of Junctions on the Field in a Waveguide—H. Buchholz. (*Arch. Elek.* (Übertragung), vol. 2, pp. 14–22; January, 1948.) Formulas are derived for the effect of a narrow circumferential slot in the wall of a waveguide on the transmission of waves having an axial component of wall current.

621.392.029.64+621.396.611.4]:621.3.015.3 3019

Study of the Transient Regimes in Waveguides and Cavity Resonators—T. Kahan and S. Colombo. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 2060–2061; June 21, 1948.) A method is given which enables formulas applicable to the transient state to be derived from formulas established for the steady state with frequency $\omega/2\pi$.

621.392.029.64:621.317.3 3020

On the Representation and Measurement of Waveguide Discontinuities—N. Marcuvitz. (Proc. I.R.E., vol. 36, pp. 728–735; June, 1948.) The various equivalent circuit representations of a general 2N-terminal waveguide structure, obtained by selection of different terminal planes, are discussed and interrelated. A precision method of measuring the circuit parameters of such structures is described. Weissfloch's tangent relation for the input versus output behavior of a four-terminal waveguide structure is used.

621.392.029.64:621.396.67 3021

The Theory of the Ring Resonant Slot in a Waveguide—M. L. Levin. (*Zh. Tekh. Fiz.*, vol. 18, pp. 639–652; May, 1948. In Russian.) A theoretical analysis is given of a resonant slot antenna having the form of a narrow ring cut in the wall of a semi-infinite waveguide of circular cross section.

621.392.43:621.317.72 3022

A Modified Micromatch—Corfield and Cragg. (*See* 3176.)

621.396.67 3023

Relations between the Transmitting and Receiving Properties of Antennas—A. F. Stevenson. (*Quart. Appl. Math.*, vol. 5, pp. 369–384; January, 1948.) A rigorous mathematical discussion. The parasitic and receiving properties of a perfectly conducting antenna can be derived from its transmitting properties under stated conditions. The particular case of a linear antenna in a homogeneous isotropic medium is considered in detail. A rigorous proof of Thévenin's theorem for antennas is given without any appeal to circuit theory. The polar diagram of an antenna used for transmission is not in general identical with that of the same antenna used for reception, though these polar diagrams are approximately identical in practical cases. Reciprocal relations between two antennas are discussed. The case of an imperfectly conducting antenna is also considered briefly.

621.396.67 3024

Calculation of the Field Strength Produced by a Half-Wave Aerial at a Given Point above a Plane Earth as a Function of the Energy Supplied per Second: Part 1—K. F. Niessen. (*Physica, 's Grav.*, vol. 7, pp. 586–602; July, 1940. In German.) Formulas are derived for the vertical field due to a $\lambda/2$ antenna with its foot at a given distance above a plane earth, taking account of the energy absorbed in the earth. Numerical results are given for various assumed values of earth conductivity and dielectric constant. See also 3025 below.

621.396.67 3025

Electric Field Strength as a Function of the Energy Supplied to the Aerial: Part 2—K. F. Niessen. (*Physical's Grav.*, vol. 7, pp. 897–908; December, 1940. In German.) Calculations are made for the same wavelength and geometrical ratios as those of part 1 (3024 above), but for values of the earth conductivity ρ and dielectric constant ϵ corresponding to dry ground. The results are compared with those of part 1 and discussed. Tables give the vertical field, due to a vertical $\lambda/2$ antenna with its foot at a height of $\lambda/4$ above a plane earth, at a distance of 5λ and a height of $\lambda/4$, for various values of ϵ and ρ, and also the corresponding fields due to a dipole. For high values of ρ the corrected reflection formula should be used, particularly when ϵ is small; for low values of ρ, Sommerfeld's formula is preferable.

621.396.67 3026

The Cylindrical Antenna with Gap—R. King and T. W. Winternitz. (*Quart. Appl. Math.*, vol. 5, pp. 403–416; January, 1948.) The King-Middleton theory (1453 and 3547 of 1946) is generalized to show the effect of a finite gap on the current and the impedance of a cylindrical antenna with a gap of length 2δ between the halves of the antenna. For small gaps, the impedance is not very sensitive to gap length, so that impedances calculated for zero gap are good approximations for antennas for which $2\pi a\delta/\lambda_0 < 0.01$, a being the radius of the conductors. For gap lengths not satisfying this inequality, correction curves are given for use with curves for resistance and reactance.

621.396.67 3027

The Field of a Dipole with a Tuned Parasite at Constant Power—R. King. (Proc. I.R.E., vol. 36, pp. 872–876; vol. 36, July, 1948.) Theoretical curves are given for the electric field, in the forward and backward directions, of a center-driven $\lambda/2$ dipole with a parallel center-tuned reflector of the same dimensions, for various values of antenna spacing and reflector impedance.

621.396.67:517.392 3028

Concerning a New Transcendent, Its Tabulation and Application in Antenna Theory—Bouwkamp. (*See* 3158.)

621.396.67:517.512.2 3029

Fourier Transforms in Aerial Theory: Part 6—Ramsay. (*See* 3159.)

621.396.671 3030

The Radiation Resistance of End-Fire and Collinear Arrays—C.H. Papas and R. King. (Proc. I.R.E., vol. 36, pp. 736–741; June, 1948.) Formulas obtained for this resistance involve circular functions and can conveniently be used for computation. The only mathematical approximation is a Fourier representation of the field of a single $\lambda/2$ dipole, discussed in 3326 of 1941 (King). The new formulas are in satisfactory agreement with the results of Pistolkors and Bontsch-Bruewitsch.

621.396.677 3031

Note on Practical Limitations in the Directivity of Antennas—R. M. Wilmotte. (Proc. I.R.E., vol. 36, p. 878; July, 1948.) Discussion on 2731 of November (Riblet).

621.396.677 3032

Artificial Dielectric Lenses for Microwaves—W. E. Kock. (*Bell. Lab. Rec.*, vol. 26, pp. 145–147; April, 1948.) For a fuller account see 2176 of September.

CIRCUITS AND CIRCUIT ELEMENTS

621.3.015.3:[621.392.029.64+621.396.611.4 3033

Study of the Transient Regimes in Waveguides and Cavity Resonators—Kahan and Colombo. (*See* 3019.)

621.314.2:[621.395.623.7 3034

Study of the Output Transformer for Feeding Loudspeakers—L. Chrétien. (*TSF Pour Tous*, vol. 24, pp. 185–188; July and August, 1948.) Discussion of the conditions which should be satisfied for optimum performance, with faithful reproduction of both high and low frequencies. Practical design details are considered briefly.

621.314.2:621.396.813 3035

Nonlinear Distortion in Low-Frequency Transformers with Strong Premagnetization—F. Böttcher. (*Frequenz*, vol. 2, pp. 140–143; May, 1948.) The distortion occurring in the load resistance is calculated under certain simplifying assumptions. The effective magnetization curve showing the relation between induction and field strength, taking account of the airgap, is thereby replaced approximately by a parabola. Values are thus derived for the harmonic and combination tones of the quadratic distortion in the secondary load, when two sinewave tones are applied to the transformer primary.

621.316.86 3036

Thermistors and Their Applications—B. S. Sotskov. (*Avtomatika i Telemekhanika*, vol. 9, pp. 39–58; January and February, 1948. In Russian.) The properties of various types are tabulated, and discussed in detail under the following headings: (a) main characteristics, (b) effect of size and shape on parameters, (c) determination of steady-state and transient regimes in thermistor circuits, and (d) applications to (i) time delay relays, (ii) starting resistances for motors, (iii) shunting resistances for lamps and other current-carrying devices connected in series, (iv) voltage stabilizers, (v) temperature measurements, (vi) gas and liquid flow measurements, (vii) bolometers and (viii) rheostats. See also 765 or 3552 of 1947 (Becker, Green, and Pearson), and 3044 of 1947 (Rosenberg).

621.318.572:621.385.38 3037
A Fast, Noiseless Thyratron Switch—S. W. Kitchen. (*Rev. Sci. Instr.*, vol. 19, pp. 370–371; May, 1948.) The cathode resistor of a conventional thyratron switch is replaced by a capacitor and a resistor of only 100 Ω is used in the anode circuit. With this arrangement, if the desired current drain through the switch is small compared with the rated average thyratron current, inherent noise is eliminated while fast action is retained.

621.392:518.4 3038
Design Curves for Parallel-T Network—D. Espy. (*Electronics*, vol. 21, pp. 114–115; July, 1948.) Generalized curves from which transmissions at various deviations from resonant frequency can be read directly. Design equations are also given.

621.392:621.396.645.029.64 3039
Very-High-Frequency Triode Oscillator and Amplifier Circuits—G. Lehmann. (*Elec. Commun.*, vol. 25, pp. 50–61; March, 1948.) Translation of paper abstracted in 368 of 1947.

621.392.011.2 3040
A Contribution to the Approximation Problem [for impedance functions]—R. F. Baum. (Proc. I.R.E., vol. 36, pp. 863–869; July, 1948.) An approximation to the curve of a given impedance function can be obtained by combining a finite number of "semi-infinite slopes," represented by Butterworth functions. The labor normally involved in the calculation of impedance zeros and poles is thus greatly reduced. Tschebyscheff functions are more appropriate for obtaining approximations to filter curves. Approximations to resistance, reactance, and phase curves can be obtained similarly.

621.392.088.7 3041
The Theory and Design of Thermal Compensation of a Circuit for a Given Frequency Range—S. S. Arshinov. (*Radiotekhnika* (Moscow), vol. 3, pp. 21–39; March and April, 1948. In Russian.) The problem of reducing as much as possible the maximum value of the temperature coefficient for a given frequency range is a particular case of finding the best approximation to a continuous function. Conditions for optimum thermal compensation in simple and complex circuits are here derived from a formula due to Tchebyschev. Complete compensation is possible for the whole operating range. A numerical example is given.

621.392.43:621.314.2 3042
Impedance Matching Half-Wave Transformer—H. E. Dinger and H. G. Paine. (*Tele-Tech.*, vol. 7, part 1, pp. 41–43, 77; May, 1948.) A transformer for matching a balanced load to an unbalanced source of the same impedance, using a $\lambda/2$ coaxial line. Since such lines can be used at 20 per cent off resonance with an impedance change of only 5 per cent, continuous coverage for the frequency range 100 to 400 Mc is achieved with 4 interchangeable lines.

621.392.5:621.385.3:512.831 3043
The Application of Matrices to Vacuum-Tube Circuits—J. S. Brown and F. D. Bennett. (Proc. I.R.E., vol. 36, pp. 844–852; July, 1948.) The matrix equations for triode circuits are derived for linear operation with any one electrode grounded. A table relating matrix elements is calculated, allowing for the fact that the networks are not bilateral. Formulas are obtained for the gain of an amplifier having *m* identical stages. Two examples showing the advantages of the matrix method are included.

621.396.611:621.316.729 3044
Pseudosynchronization in Amplitude-Stabilized Oscillators—P. R. Aigrain and E. M. Williams. (Proc. I.R.E., vol. 36, pp. 800–801; June, 1948.) If a frequency f is injected into an amplitude-stabilized oscillator of frequency f_0, then over a band of frequencies for which $|f-f_0|$ is small, f_0 disappears and the system acts as a regenerative amplifier for the injected signal and "pulling" does not exist. These results are contrasted with those of Adler (2522 of 1946).

621.396.611.015.4 3045
Notes on a Property of the Voltage Resonance of an Oscillatory Circuit—E. Fromy. (*Onde Élec.*, vol. 28, pp. 218–221; June, 1948.) Starting from the elementary equations of an oscillatory circuit fed by a sinusoidal source, it is shown that the terminal voltage can be regarded as the sum of two voltages, whose amplitudes are constant and equal to half the terminal voltage of the circuit at resonance; one voltage is of constant phase, while the phase of the other varies on either side of the phase at resonance, according to the value of the tuning capacitance. This property is quite general and is established without making any simplifying assumptions; it can have numerous practical applications, particularly in the design of dephasing circuits.

621.396.611.1 3046
The Application of the Symbolic Method to the Analysis of the Free Régime of Linear Systems—A. A. Rizkin. (*Radiotekhnika* (Moscow), vol. 3, pp. 56–63; May and June, 1948. In Russian.) A general analytical method is proposed which is based on breaking the circuit under consideration at some point and determining the input impedance at this point. By equating this "characteristic" impedance to zero or infinity (depending on the properties of the circuit) a characteristic equation of the circuit is obtained. Five examples of the application of this method are given.

621.396.611.1 3047
The Starting of Oscillations in RC Generators—G. Gillard. (*TSF Pour Tous*, vol. 24, pp. 132–134; May, 1948.) A nonmathematical explanation.

621.396.611.21 3048
Series Mode Crystal Circuits—H. Goldberg & E. L. Crosby, Jr. (*Tele-Tech*, vol. 7, part 1, pp. 24–27, 86; May, 1948.) The equivalent circuit of a piezoelectric quartz crystal near resonance is considered; in a typical crystal, the series and parallel resonant frequencies are close together. A 118-Mc direct-operation circuit including a 7F8 twin triode is described; the eleventh mechanical harmonic of the crystal is used. This circuit can be modified for use as a converter.

621.396.611.21 3049
On the Equivalent Circuit and Performance of Plated Quartz Bars—J. K. Clapp. (*Gen. Radio Exp.*, vol. 22, pp. 1–7; March and April, 1948.) The impedance and equivalent electric circuit are derived for a long bar. Both mechanical and electrical stability for low-frequency modes of vibration are improved by the use of tension mounting and by operation at the second harmonic. Zero temperature coefficient can be obtained for a particular temperature.

621.396.611.4 3050
On the Design of Circuits Equivalent to Cavity Resonators—N. N. Malov. (*Zh. Tekh. Fiz.*, vol. 18, pp. 421–430; April, 1948. In Russian.) The conditions of equivalence are defined and a general design method is discussed; this is used to determine a circuit equivalent to
a cylindrical resonator in which a standin
wave of the H_{011} type is present.

621.396.611.4 305
**A Method of Feeding Microwave Power int
a Resonator Having a Fine Mode Structure**—
G. R. Newbery and W. E. Willshaw. (*Natur*
(London), vol. 161, pp. 519–520; April
1948.) Power was fed into a 24-cavity resonato
120 cm long, the frequency separation betwee
the required mode of operation and the ad
jacent mode being only 0.2 per cent (6 Mc)
The required mode had a phase difference o
π between currents in adjacent cavities.
pulsed magnetron, Type E1944, was driven a
500 pulses per second, with 2 μs pulses, by a
Admiralty Type 277 modulator with a pea
output of 1.25 Mw. An estimated peak power o
390 kw was fed into the resonator.

621.396.615 305
**Use of Ordinary Valves as Microwave Os
cillators**—G. Fonda-Bonardi. (*Alta Frequenza*
vol. 17, pp. 69–73; April, 1948. In Italian wit
English, French, and German summaries.
The power output of an oscillator using a
ordinary tube becomes zero when the oscilla
tion frequency is so high that the electron tran
sit time is a substantial fraction of the oscilla
tion period. Oscillations can be obtained, how
ever, when the transit time is a multiple of th
oscillation period. A circuit using a 6V6 tub
with a Lecher-line oscillatory circuit is de
scribed, with which frequencies from 1000 M
to 3000 Mc have been obtained.

621.396.615 305
**The Self-Modulation of Auto-Oscillation
in a Valve Oscillator with Automatic Biasing i
the Cathode Circuit**—N. A. Zheleztsov. (*Zh*
Tekh. Fiz., vol. 18, pp. 495–508; April, 1948. I
Russian.) An analysis of the operation of th
oscillator depicted in Fig. 1, using simplifie
tube characteristics and the van der Pol meth
od of "abbreviated" equations. Methods ar
indicated for determining the amplitude of auto
oscillations and the conditions necessary for th
appearance of self-modulation are found. Pho
tographs are shown of phase trajectories on th
van der Pol plane obtained with a cro. Th
gradual appearance of self-modulation is thu
confirmed experimentally.

621.396.615 305
**An Investigation of a Relaxation Oscillato
of the Transitron Type**—V. V. Migulin an
T. N. Yastrebtsova. (*Zh. Tekh. Fiz.*, vol. 1
pp. 603–614; May, 1948. In Russian.) An ex
perimental investigation in which an extern
sinusoidal emf is applied to a *RC* oscillator op
erating in the regime of free auto-oscillation
Results are in good agreement with the theor
of such oscillators, which is also discussed.

621.396.615.14:621.316.726.078.3 305
**Recent Developments in Frequency Sta
bilization of Microwave Oscillators**—W.
Tuller, W. C. Galloway, and F. P. Zaffaran
(Proc. I.R.E., vol. 36, pp. 794–800; June
1948.) Pound's stabilizer (1690 of 1947 and 131
of June) is discussed. The usable frequency rang
of the stabilizing circuit can be increased b
changing the microwave circuit; this change
considered in detail and a graphical method
obtaining the frequency versus voltage chara
teristic is explained. The amount of harmon
distortion in the output of the stabilizing circu
is calculated for the case where the microwav
oscillator has FM.

621.396.615.17 305
Electrical Sawtooth Oscillations—H. Her
wig. (*Funk und Ton*, vol. 2, pp. 300–307; Jun
1948.) Discussion of the conditions governi
the rise and fall for both linear and exponent
wave forms, with formulas for rise and f
times, frequency, and mean value of the cu
rent.

621.396.619.16 3057
On Some Characteristic Pulse Circuits—J. Moline. (*Radio Franç.*, pp. 11–15; May, 1948.) Details of circuits for: (a) low-power pulses, using phasing or dephasing, (b) frequency multipliers and dividers, and (c) high-power pulses suitable for the modulation of high-frequency transmitters.

621.396.619.23:621.395.44 3058
Linear Theory of Bridge and Ring Modulator Circuits—V. Belevitch. (*Elec. Commun.*, vol. 25, pp. 62–73; March, 1948.) The question of impedance mismatch between filters and modulators, and the losses in CuO-rectifier type modulators, are considered with reference to single-sideband carrier telephone systems. With stated assumptions and approximations, a simplified, practical theory is developed for bridge and ring modulators working between various ideal filter terminations. The transmission loss of a bridge modulator is measured experimentally under different terminating conditions approximating to those already assumed. Means of partially compensating for parasitic capacitance are described; these provide a basis for verifying the theory. An expression is given for the extra loss caused by the addition of capacitance to a capacitance-compensated modulator.

621.396.622.6:546.28 3059
The Silicon Crystal Detector—(*Bell Lab. Rec.*, vol. 26, pp. 152–155; April, 1948.) A short historical survey of development.

621.396.645 3060
The Use of Cathode Followers in the Penultimate Stage of Power Amplifiers—S. E. Glikman. (*Vestnik Svyazi*, no. 6, pp. 9–11; 1948. In Russian.)

621.396.645 3061
A Low-Noise Amplifier—H. Wallman, A. B. Macnee, and C. P. Gadsden. (Proc. I.R.E., vol. 36, pp. 700–798; June, 1948.) The "cascode" amplifier consists of a grounded-cathode triode followed by a grounded-grid triode. The combination is noncritical and has the low noise factor of a triode with the amplification and stability of a pentode. Noise factors averaging 0.25 db at a carrier frequency of 6 Mc and 1.35 db at 30 Mc have been achieved. Typical circuit details are given. Summary noted in 2475 of October.

621.396.645 3062
Time Response of an Amplifier of *N* Identical Stages—E. F. Grant. (Proc. I.R.E., vol. 36, pp. 870–871; July, 1948.) The response to a unit-step voltage is calculated, assuming that the pass band is so narrow compared to the center frequency that a low-pass equivalent circuit will describe the behavior of the amplifier with sufficient accuracy.

621.396.645 3063
Amplifier Load Impedance Reduction—B. M. Hadfield. (*Tele-Tech*, vol. 7, part 1, pp. 33–35, 82; May, 1948.) Design equations for amplifiers to deliver power into low-value load impedances over a wide range of frequencies, without the use of high-ratio output transformers. A specific example is considered in detail.

621.396.645:518.3 3064
Exact Design and Analysis of Double- and Triple-Tuned Band-Pass Amplifiers—M. Dishal. (*Elec. Commun.*, vol. 25, pp. 100–102; March, 1948.) Reprint of discussion on 3065 of 1947 already noted in 1315 of June. Reprint of original paper noted in 2493 of October.

621.396.645:537.533.9 3065
Use of Photo-Conductive Semiconductors as Amplifiers—E. S. Rittner. (*Phys. Rev.*, vol. 73, pp. 1212–1213; May 15, 1948.) The advantages of using a photoconductive semiconductor instead of an insulator as an amplifier are enumerated. Optimum results will probably be achieved with thin specimens of the same order of thickness as the penetration depth of the primary electron beam. Preliminary results for a polycrystalline layer of Se on glass are described. Further work on Se, Si, Ge, and PbS is in progress. See also 2757 of November.

621.396.645:539.16.08 3066
A Battery-Fed Amplifier for Counter Tubes with Continuous Generation of the Counter-Tube Voltage from an Accumulator Battery—A. Flammersfeld. (*Z. Naturf.*, vol. 1, pp. 168–170; March, 1946.) From the counter impulses the amplifier produces current pulses of constant length. The circuit is an improvement on that described by Neher (1697 of 1939). In the high-voltage generator, the tetrode anode current of a tetrode-triode sawtooth-wave generator is used to feed the primary of an ordinary mains transformer, whose secondary gives a series of high-voltage peaks.

621.396.645:621.396.822 3067
An Investigation of Amplifier Noise at Ultra High Frequencies—V. I. Siforov. (*Radiotekhnika* (Moscow), vol. 3, pp. 5–24; May and June, 1948. In Russian.) The theory of the one-stage amplifier is developed from consideration of an equivalent circuit consisting of a series of quadripoles in which an active noise-generating quadripole is included. Conditions for obtaining the maximum signal-to-noise ratio are established. The necessary and sufficient conditions for neutralizing tube noise are derived. The fundamental noise relationships in a multistage amplifier are determined; the noise factor of the amplifier can be deduced.

621.396.662 (083.74) 3068
Standardization of Tuning Units and Oscillators, 1948—Radionyme. (*Toute la Radio*, vol. 15, pp. 190–193. June, 1948.) A general discussion of the standards for 1939 and 1940 adopted by the Syndicat professionnel des Industries radioélectriques, with details of the standards proposed for 1948 by the SNIR (Syndicat national des Industries radioélectriques), which has taken the place of the SPIR. The new standards include variable capacitors of 490 pF and 130+360 pF max. respectively, and 3- and 4-waveband tuning units for which suitable capacitance values are tabulated.

621.396.662.21 3069
Design Calculations for Short-Wave Band-Spread Coils—J. Henry. (*Radio Franç.*, pp. 4–10; May, 1949.) Detailed calculations are made for tapped coils for the band 7 to 7.3 Mc; general formulas applicable to the whole of the short-wave bands are given. Tapped coils enable a single standard 460-pF capacitor to be used, and give a more linear spread than the series-capacitor method.

621.396.662.3 3070
An Experimental Investigation of the Wave-Guiding Properties of Multi-Terminal Filters—V. V, Potemkin. (*Zh. Tekh. Fiz.*, vol. 18, pp. 447–454; April, 1948. In Russian.) Experiments were carried out with the ladder-type filters depicted in Figs. 1 and 2, to verify theoretical conclusions regarding various phenomena occurring in them, such as the appearance of different types of waves, dispersion of natural waves, band-pass filtering, and interruptions in the propagation of certain waves.

621.396.662.3 3071
Band Stoppers with Oscillating Crystals—W. Herzog. (*Arch. Elek.* (Übertragung), vol. 2, pp. 22–38; January, 1948.) Theory is given and design formulas are derived for both narrow- and broad-band stoppers. Suitable designs are given, with their functional characteristics, for (a) a broad-band stopper circuit using 2 crystals and 2 inductors, and (b) a narrow-band stopper using 3 crystals and 2 inductors.

621.396.662.3:621.396.611.21 3072
Quartz Filter Crystals with Low Inductance—J. J. Vormer. (Proc. I.R.E., vol. 36, pp. 802–804; June, 1948.) English version of 388 of March.

621.396.662.3:621.396.645 3073
A 3-Stage Coupling Filter for Wide-Band Amplifiers—P. G. Violet. (*Funk und Ton*, vol. 2, pp. 290–299; June, 1948.) Theory, design formulas, and practical details of a filter whose response curve shows three slight humps of equal height within the pass band, with relatively sharp cutoff at both limits.

621.396.665 3074
Adjustment Speed of Automatic-Volume-Control Systems—A. W. Nolle. (Proc. I.R.E., vol. 36, pp. 911–916; July, 1948.) The behavior of an avc amplifier, following a sudden change of input level, is analyzed on the basis of certain assumptions which are usually justified in practice. Equations are developed for the overload case and applied to a particular amplifier.

621.396.69:06.064 Paris 3075
Components, 1948—G. Giniaux. (*TSF Pour Tous*, vol. 24, pp. 57–60, 92–96, and 142–143; March to May, 1948.) Discussion of the special features of the Paris exhibition. See also 1898 of August.

621.396.621.001.4+621.397.62.001.4 3076
Most-Often-Needed F.M. and Television Servicing Information [Book Review]—M. N. Beitman. Supreme Publications, Chicago, 1948, 191 pp., $2.00. (Proc. I.R.E., vol. 36, p. 884; July, 1948.)

GENERAL PHYSICS

53.081+621.3.081 3077
On Systems of Electrical Units—É. Brylinski. (*Rev. Gén. Élec.*, vol. 57, pp. 200–204; May, 1948.) The use of the absolute systems of electrical units leads to certain difficulties, which are discussed. It is considered preferable to abandon the absolute systems and adopt electrostatic and electromagnetic systems defined by the condition that the dielectric constant of a vacuum is the unit of dielectric constant, or that the permeability of a vacuum is the unit of magnetic permeability. These systems give the same numerical measures of electrical quantities as the absolute systems. See also 2504 of October (Dzung and Meldahl) and back references.

530.145 3078
On the Quantum Theory of Wave Fields—F. J. Belinfante. (*Physica, 's Grav.*, vol. 7, pp. 765–778; October, 1940. In English, with German summary.)

535.215.6:621.383.5 3079
Theory of the Barrier-Layer Photoeffect—K. Lehovec. (*Z. Naturf.*, vol. 1, pp. 258–264; May, 1946.) Differential equations are established involving the relation between photocurrent and voltage, intensity of illumination, frequency of the light waves, the properties of the semiconductor and of the electrode, and the resistance of the external circuit. The properties of defect and excess semiconductors are discussed.

535.37 3080
Relation between Photoconduction and Luminescence in Zinc Sulphide—M. H. F. Wilkins and G. F. J. Garlick. (*Nature* (London), vol. 161, pp. 565–566; April 10, 1948.)

537.213:517.1:532.58 3081
On the Harmonic and Biharmonic Problems of a Region Bounded by a Circle and two Paral-

No reprints or preprints of these abstracts and references are available from the I.R.E.

lel Lines—R. Westberg. (*Ingen. Vetensk. Akad. Handl.*, no. 197, 66 pp.; 1948. In English.) Analysis of the potential field of a circular cylinder between two parallel conducting planes, and also of the motion of a circular cylinder in a viscous fluid between two parallel planes.

537.228.1 3082

Equations of Piezoelectricity—R. K. Cook. (*Nature* (London), vol. 161, pp. 524–525; April 3, 1948.) In Cady's book on piezoelectricity (2084 of 1947), some confusion between generalized co-ordinates and forces in the Lagrange function results in erroneous piezoelectric equations. This gives rise to errors in the basically important linear equations which give the elastic stresses and electric field intensities as functions of the elastic strains and electric displacements.

537.228.1+539.3]:512.9 3083

Applications of Tensor Analysis to Elasticity and Piezoelectricity—J. H. Jurmain. (*Jour. Frank. Inst.*, vol. 245, pp. 475–500; June, 1948.) A systematic theory of elasticity, based on tensor analysis, is developed and shown to give results consistent with those derived by other methods. The theory is extended to piezoelectricity and, if boundary conditions are carefully selected, the general solutions obtained are applicable to practical problems. Examples are given.

537.312.62 3084

On the Theory of Superconductivity—F. J. Wiśniewski. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1964–1965; June 14, 1948.) A possible mechanism for superconductivity is described. The fundamental equation of London is deduced from the principles of mechanics.

537.52 3085

The Breakdown of Gases in High Frequency Electrical Fields—D. H. Hale. (*Phys. Rev.*, vol. 73, pp. 1046–1052; May 1, 1948.) "It is assumed that breakdown occurs when the electrical field and the frequency are such that an electron acquires the ionizing energy at the end of one mean free path. The field for breakdown is thus a function of the frequency of the applied potential and the ionization potential and pressure of the gas. The fields for breakdown of argon and xenon are calculated and expressed as functions of the frequency and the gas pressure." Good agreement between calculated potentials and experimental results is found for frequencies >10 Mc.

537.523.5 3086

On the Theory of the High-Current Arc Column—P. Schulz. (*Z. Naturf.*, vol. 2a, pp. 662–666; November and December, 1947.)

537.533.9:621.396.645 3087

Use of Photo-Conductive Semiconductors as Amplifiers—Rittner. (*See* 3065.)

538.1 3088

On the Current and the Density of the Electric Charge, the Energy, the Linear Momentum and the Angular Momentum of Arbitrary Fields—F. J. Belinfante. (*Physica, 's Grav.*, vol. 7, pp. 449–474; May, 1940. In English, with German summary.)

538.213:538.221 3089

Determination of Magnetic Permeability from Resistance Measurements on Iron Wires of Different Structure at Frequencies of the order of 100 Mc/s, in relation to the Weiss Elementary Domains—M. J. O. Strutt and K. S. Knol. (*Physica, 's Grav.*, vol. 7, pp. 635–654; July, 1940. In German, with English summary.) The high-frequency permeability calculated from the ratio of the ac and dc resistances is practically constant at room temperature up to about 300 Mc, but shows a marked decrease with increasing frequency at −183° C. An explanation of this is based on a simple model, which permits the determination of the order of magnitude of the Weiss domains for the different wires.

538.21 3090

Effect of Reversible and Irreversible Variations of Magnetization on the Thermoelectric Power of Ferromagnetic Materials—J. Bouchard. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1895–1897; June 7, 1948.)

538.23 3091

On the Effective Length of a Small Barkhausen Discontinuity—J. L. Snoek. (*Physica, 's Grav.*, vol. 7, pp. 609–624; July, 1940. In English, with German summary.) The effective length is calculated for a wire of square cross section and found to be equal to the product of the reversible permeability and the wire thickness.

538.242 3092

On the Theory of Gyromagnetic Effects—C. J. Gorter and B. Kahn. (*Physica, 's Grav.*, vol. 7, pp. 753–764; October, 1940. In English, with French and German summaries.)

538.56+621.385.029.63/.64+621.384.6 3093

Waves and Electrons Traveling Together—A Comparison between Traveling Wave Tubes and Linear Accelerators—L. Brillouin. (*Phys. Rev.*, vol. 74, pp. 90–92; July 1, 1948.) Traveling-wave tubes operate with high space charge and weak waves of constant velocity, while "synchro-" devices use very low space charge and high-power waves whose velocity is progressively increased. In one case, there is an energy transfer from the electrons to the wave, which is strongly amplified; in the other case, energy is transferred from the wave to the particles, which are thereby accelerated. A general theory is needed that would include both extreme cases of traveling-wave amplifiers and linear accelerators without introducing any restriction on the magnitudes of either fields or space charge. A composite wave is considered which has discontinuities in the derivative of the longitudinal field distribution and represents a sort of electromagnetic shock wave. It yields a rigorous solution of the wave equation for the case of space charge, and represents a generalization of the two extreme cases.

538.566 3094

Remarks on Spherical Electromagnetic Waves—V. Sorokin. (*Zh. Eksp. Ter. Fiz.*, vol. 18, pp. 228–235; February, 1948. In Russian.) Using vectorial spherical functions, simple formulas are derived for spherical electromagnetic waves in vacuo and for electromagnetic fields of multipoles.

538.566 3095

A New Formula for Calculating the Phenomena of Diffraction—É. Durand. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1812–1814; May 31, 1948.)

538.566 3096

Electromagnetic Theory of Diffraction by Black Screens—É. Durand. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1972–1974; June 14, 1948.)

538.566:535.42 3097

Diffraction of Centimeter Electromagnetic Waves at an Aperture in a Metal Sheet—H. Severin. (*Z. Naturf.*, vol. 1, pp. 487–495; September, 1946.) The Huyghens-Fresnel principle, formulated for radio waves, is applied to the accurate quantitative determination of diffraction effects along the normal through the center of a circular aperture and also in the field near the aperture. Experiments with apertures of radius ranging from $\lambda/2$ to 8λ, and with wavelengths of 10 cm. and 6 cm, confirm the theory, which is in agreement with Kirchhoff's diffraction theory and Maxwell's equations. See also 2326 of September (Tranter).

538.569.4:535.61-15:525.7 3098

Transmission of the Atmosphere in the 1-5 Micron Region—A. Elliott and G. G. MacNeice. (*Nature* (London), vol. 161, p. 516; April 3, 1948.) Details of equipment for measurements over a 600-yard path. A typical transmission curve shows high values between 3μ and 4μ, where transmission is comparable with that at 2.2μ.

538.569.4:546.331.31-145.1 3099

Absorption of U.H.F. Waves in Salt Solutions—S. K. Chatterjee and B. V. Sreekantan. (*Indian Jour. Phys.*, vol. 22, pp. 229–242; May, 1948.) The absorption index is measured directly by a free-wave method at frequencies between 300 and 500 Mc for concentrations ranging from N/2 to N/16. Reflection coefficients at different frequencies are calculated; the values of ionic relaxation time, dielectric constant, and loss angle obtained are compared with theoretical values deduced from the Debye-Falkenhagen theory. The product of the wavelength for maximum absorption and the concentration of the solution is approximately constant.

538.569.4.029.64:546.171.1 3100

Collision Broadening of the Ammonia Inversion Spectrum at High Pressures—B. Bleaney and J. H. N. Loubser. (*Nature* (London), vol. 161, pp. 522–523; April 3, 1948.) Measurements have been extended over the frequency range 0.1 to 1.2 cm^{-1} at pressures up to 6 atmospheres. See also 1916 of August and back references.

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

523.53:621.396.96 3101

Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation—C. D. Ellyett and J. G. Davies. (*Nature* (London), vol. 161, pp. 596–597; April 17, 1948.) The radiation scattered from the electron trail was observed as the meteor crossed the antenna beam; the variation in received power is compared with Fresnel's integrals for diffraction at a straight edge. The mean geocentric velocity deduced for the Geminid meteors is 34.4 km, in good agreement with Whipple's value of 34.7 km obtained from photographic measurements of visible meteors.

523.72+523.16]:621.396.822 3102

Radio Noise of Extra-Terrestrial Origin and Its Effect on Telecommunication Technique—G. Lehmann. (*Onde Élect.*, vol. 28, pp. 164–172 and 200–205; April and May, 1948.) The present state of knowledge of cosmic noise is reviewed, reference being made to investigations on wavelengths ranging from decameters to millimeters. The fundamental principles of thermodynamics necessary for the interpretation of the experimental results are recalled, receiver noise factor is defined and a method of measuring it is described. The performance of actual uhf receivers is compared with that which is theoretically possible.

523.72.029.63:523.746 3103

A Solar Noise Outburst at 600 Mc/s and 1200 Mc/s—F. J. Lehany and D. E. Yabsley. (*Nature* (London), vol. 161, pp. 645–646; April 24, 1948.) Bursts similar to those at 200 Mc described in 412 of March (McCready, Pawsey, and Payne-Scott) are not normally observed at 600 and 1200 Mc; noise level rises gradually as the sunspots appear, and shows correlation with sunspot area. On one occasion only, large bursts occurred at 600 and 1200 Mc, but not at 200 Mc.

No reprints or preprints of these abstracts and references are available from the I.R.E.

523.746 3104

Magneto-Hydrodynamic Waves and Sunspots: Part 3—H. Alfvén. (*Ark. Mat. Astr. Fys.* vol. 34, part 4, section A, 20 pp.; April 13, 1948. In English.) The instability factor θ_s is zero at the center of the sun, rises to a maximum as distance from the center is increased radially, and thereafter falls again to zero at the surface of the unstable core.

A disturbance in the zone of maximum instability in, say, the northern hemisphere gives rise to two hydrodynamic waves traveling in opposite directions parallel to the magnetic field. One waves escapes into the stable zone and on reaching the surface of the sun gives rise to a spot. The other passes through the unstable core and is subject to an acceleration, which is a function of θ_s, and is negligible until the southern zone of maximum instability is reached. Any acceleration of the wave results in a new disturbance and a new pair of waves having amplitudes proportional to the acceleration. Thus there are two strong waves emitted from this southern zone: one forms a spot in the southern hemisphere of the sun and the other retraces the path through the core. The process is repeated until it is attenuated to negligible proportions. We should thus expect a harmonic process of period T, the time taken for the wave to cross the core. T can be shown to be about 11 years.

The theory would also predict a correlation between sunspot activity at a given latitude in one hemisphere at a given epoch of one cycle and that at the same latitude in the other hemisphere in adjacent cycles. Statistical analysis, noted in 3105 below, confirms this hypothesis. For previous parts see *Mon. Not. R. Ast. Soc.*, vol. 105, pp. 3–16 and 382–394; 1945; abstracts of these will appear shortly. See also 2231 of September (Cowling) and back references.

523.746:519.251.8 3105

Statistical Tests of H. Alfvén's Theory of Sunspots—I. Galvenius and H. Wold. (*Ark. Mat. Astr. Fys.*, vol. 34, part 4, section A, 9 pp.; April 13, 1948. In English.) See 3104 above.

523.746:621.396.11 3106

Sunspots and Radio Weather—A. Arzinger, H. E. Hallborg, and J. H. Nelson. (*RCA Rev.*, vol. 9, pp. 229–244; June, 1948.) The sunspots producing disturbance in high-frequency radio communication are found to lie mainly within a semicircle of about 26° radius in the eastern half of the solar disk; its center coincides with that of the disk. The spots have maximum effect when they cross either the circle or the central meridian. While they are within the semicircle they cause erratic conditions. Studies of the polarities of the spots show that, for the northern hemisphere, "reds" (positive) have a preponderant effect and tend to lower frequencies, while "violets" (negative) tend to raise them. The reverse is true for the southern hemisphere. These observations, in combination with Washington F-layer data, are applied to short-period radio-weather forecasting.

523.752 3107

A Chromospheric Eruption of Extraordinary Size—A. Behr. (*Z. Naturf.*, vol. 1, pp. 537–539; September, 1946.) An account, with photographs, of a very large eruption observed at the Fraunhofer Institute on July 25, 1946, and of simultaneous recording of the field strength of a London 9.66-Mc transmission. The field strength fell to a low value at the commencement and remained low for the duration of the eruption. About 26½ hours after the start of the eruption, a geomagnetic storm was recorded at the Hamburg-Wingst observatory; this time lag corresponds to a velocity of the particle radiation from the sun of 1570 km. An aurora of medium brightness was observed for about an hour at Freiburg some 6 hours after the start of the magnetic storm. This was also seen in Paris and in Switzerland.

538.12:521.15 3108

Blackett's Hypothesis of the Magnetic Field of Rotating Bodies—N. Arley and J. Fuchs. (*Nature* (London), vol. 161, pp. 598–599; April 17, 1948.) Comment on 3112 of 1947 (Blackett). Difficulties involved in Blackett's interpretation are discussed by Arley and possible experimental tests suggested, such as those of Barnett on gyromagnetic magnetization, and of Einstein and de Haas on the inverse effect of rotation by magnetization.

Fuchs interprets Blackett's constant of proportionality by expressing it in a dimensionless form valid for the nonrational electromagnetic system of units as well as the usual nonrational electrostatic system.

550.384:551.510.5:525.624 3109

A Possible Influence of the Moon on Recurrent Geomagnetic Activity—O. R. Wulf and S. B. Nicholson. (*Phys. Rev.*, vol. 73, pp. 1204–1205; May 15, 1948.) Tidal air mounds due to the moon may be one of the factors which account for the observed 27-day period of geomagnetic activity. See also 3900 of 1947.

550.384:551.510.535:523.7 3110

Evidence of a Solar Effect on the Ionized Regions of the Upper Atmosphere—P. Lejay, A. Haubert, and J. Durand. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1768–1770; May 31, 1948.) Comparison of continuous records of F_2-layer critical frequency variations and magnetic K-indexes for September 1946, reveals a definite correlation between the two. The variations corresponding to magnetic storms have, in general, the same sense at stations as far apart as Slough, England, and Washington, D. C. The fact that the observed variations are generally greatest in the middle of the day, when the sun is high, suggests a quasi-instantaneous action of the sun.

550.384.3 3111

Basis and Preparation of the Magnetic Deviation Chart for the Epoch 1945—O.-F. Burmeister. (*Beitr. Geophys.*, vol. 60, nos. 3 and 4, pp. 177–195; 1944.) Discussion of all the data, from various sources, on which the chart was based.

550.384.3 3112

A Contribution to the Knowledge of Magnetic Secular Variation—A. Kiskyras. (*Beitr. Geophys.*, vol. 60, nos. 3 and 4, pp. 222–234; 1944.) Discussion based on the theory that the greater part of the secular variation is due to changes in the magnetization of the rocks in the upper 20 km of the earth's crust. Such changes are brought about by changes of temperature.

550.385 "1941.03.01":537.591 3113

Contribution to Material on the Effect of the Magnetic Storm of 1st March 1941 on Cosmic Radiation—A. Sittkus. (*Z. Naturf.*, vol. 1, pp. 204–208; April, 1946.) The results published by Kölhorster (12 of 1945) were obtained at Dahlem and Graz by coincidence methods. Ionization-chamber measurements at Freiburg i. Br. are here described and an estimate is made of the temperature effect at all three stations. The effect of the magnetic storm was qualitatively similar for the three places, though the amplitudes of the fluctuations differed.

551.510.53 (479) 3114

The Structure of the Upper Layers of the Atmosphere as determined by Twilight Observations—T. G. Megrelishvili and I. A. Khvustikov. (*Compt. Rend. Acad. Sci.* (URSS), vol. 59, pp. 1283–1286; March 1, 1948. In Russian.) Values of upper-air density and pressure deduced from spectrophotometric observations have been obtained regularly since 1942 at Abbastuman observatory (South-West Caucasus) during morning and evening twilight. Results agree closely with those of other workers using different methods.

551.510.535 3115

An Approach to the Approximate Solution of the Ionosphere Absorption Problems—J. E. Hacke, Jr. (PROC. I.R.E., vol. 36, pp. 724–727; June, 1948.) A series of parabolic approximations has been obtained for portions of the Chapman distribution and its product with the collisional frequency. By their use, an improved approximate solution has been found for the "true" and the group height of reflection, and for the absorption in the region, under conditions of (a) vertical incidence, (b) wave frequency greater than the maximum collision frequency and less than the critical frequency for the region, and (c) with the earth's magnetic field neglected.

"These improved analytic approximations are compared with the usual parabolic approximation and with numerical approximations obtained by other workers."

551.510.535 3116

Electrical Conductivity of the Ionospheric D-Layer—T. G. Cowling and R. Borger. (*Nature* (London), vol. 161, p. 515; April 3, 1948.) Martyn's suggestion (1024 of May), that electric currents in the D layer must make a contribution to the solar and lunar geomagnetic variations roughly equal to that of the E and F layers, implies that the integral conductivity of the D layer must be as great as that of the E and F layers combined. Discussion shows this to be improbable.

551.510.535:621.396.11 3117

Upper-Atmosphere Circulation as Indicated by Drifting and Dissipation of Intense Sporadic-E Clouds—O. P. Ferrell. (PROC. I.R.E., vol. 36, pp. 879–880; July, 1948.) The motion of such clouds is illustrated by a series of maps for two recent occasions when the clouds were sufficiently intense to permit long-range communication in the 50 to 54-Mc amateur band.

551.510.535:621.396.11 3118

Triple Splitting of Ionospheric Rays—Eckersley. (*See* 3222.)

551.510.535:621.396.11 3119

Triple Splitting of Ionospheric Rays—Meek. (*See* 3221.)

551.513 3120

Intensity of the Zonal Circulation in the Atmosphere outside the Tropics—H. Flohn. (*Beitr. Geophys.*, vol. 60, nos. 3 and 4, pp. 196–209; 1944.) From new circumpolar charts of the atmospheric temperature and pressure distributions in the northern hemisphere, new mean values of the zonal component of the currents at heights of 5, 11, 16, and 22 km in temperate latitudes are deduced. Marked differences are found between the continental and maritime sectors.

551.578.1:621.396.96 3121

Measurement of Rainfall by Radar—J. S. Marshall, R. C. Langille and W. McK. Palmer. (*J. Met.*, vol. 4, pp. 186–192; December, 1947. Reprint.) Experiments using 10-cm radar equipment have confirmed theoretical conclusions that the radiation reflected from rain is proportional to Z, the sum of the sixth powers of diameters of raindrops in a representative volume. Correlation of Z with rainfall intensity R at ground level suggests that $Z \propto R^2$, approximately. It may be possible to determine rainfall intensity 100 km away by radar echo, since vertical scanning indicates that rain content varies only slightly with height. See also 2062 of August (Ryde) and back reference.

No reprints or preprints of these abstracts and references are available from the I.R.E.

LOCATION AND AIDS TO NAVIGATION

621.396.93:551.594.6 3122

Distant Localization of Individual Atmospherics with a Cathode-Ray Direction-Finder of Unidirectional Type—W. Stoffregen. (*Ark. Mat. Astr. Fys.*, vol. 34, part 4, section A, 14 pp.; April 13, 1948. In English.) An improved form of cathode-ray direction finder is described in which a "sense antenna" eliminates an uncertainty of 180° by blacking out the negative half-cycle. Radar technique is used to determine the range.

621.396.933 3123

C.A.A. V.H.F. Omnidirectional Range at United Air Lines—F. J. Todd. (*Communications*, vol. 28, pp. 10–11, 34; April, 1948.) The new system referred to as VOR (vhf omnidirectional range) has the advantages of improved accuracy of indication, comparatively static-free operation, greater flexibility, and channel assignments adequate to accommodate the needs of expanding air traffic. The system provides the information necessary to enable an aircraft to fly along a definite path with respect to the VOR station. The component parts of the equipment are described.

621.396.96 3124

Frequency-Modulated Radar Techniques—I. Wolff and D. G. C. Luck. (*RCA Rev.*, vol. 9, pp. 352–362; June, 1948.) Continuation of 2798 of November. Two superheterodyne systems, namely a sideband system and a signal-following system, remove the transmitted modulation from the received if signal. An electromechanical device using a vibrating capacitor and an electronic device using a beam of electrons have proved useful for FM of radar oscillators. Several adaptations of the well-known cycle-rate counter for making use of beat-frequency data have made FM radar very useful where automatic indication of, or control by, the range and speed of a single target is needed. To be continued.

621.396.96 3125

Technique and Development of Radar—Demanche. (*Onde Élec.*, vol. 28, pp. 206–210; May, 1948.) Discussion of methods of eliminating permanent echoes. See also 1366 of June.

MATERIALS AND SUBSIDIARY TECHNIQUES

535.5 3126

On the Theory of the Diffusion Pump—R. Jaeckel. (*Z. Naturf.*, vol. 2a, pp. 666–677; November and December, 1947.) The physical processes in the diffusion pump are treated theoretically and first- and second-approximation formulas for quantitative calculation are derived. From these formulas the power of a diffusion pump or the design characteristics for a pump of given power can be determined.

535.37 3127

The Effect of Electron Distribution at Localized Levels on the Course of Different Luminescence Processes in the CaS • SrS-Ce, Sm, La Phosphors and the Number of Repeated Electron Localizations—V. L. Levshin. (*Zh. Eksp. Teor. Fiz.*, vol. 18, pp. 149–163; February, 1948. In Russian.) An experimental investigation which shows that the luminescence processes depend not only on the number of ionized centers and localized electrons but also on the electron distribution at localized levels. It is shown that the number of repeated localizations of electrons is not great. Repeated flashes and phosphorescence are examined in detail.

535.37 3128

The Nature of Centres of Luminescence in Photochemically-Coloured Alkali-Halide Crystals—M. L. Katz. (*Zh. Eksp. Teor. Fiz.*, vol. 18, pp. 164–173; February, 1948. In Russian.)

535.37 3129

On a Group of Mixed Phosphors with Mixed Activators—P. Brauer. (*Z. Naturf.*, vol. 1, pp. 70–78; February, 1946.) An investigation of the properties of mixed sulphides of the alkaline earths with Sm as one activator and either Ce, Pr, Eu, Mn, or Pb as the other. The behavior of SrS · Eu-Sm differs considerably from that of other members of the group, whose general properties can be explained on the assumption that Sm acts as a "killer" substance. See also 762 of 1940.

535.37:535.61-31 3130

Miscellaneous Observations on the Rise and Decay of the Luminescence of Various Phosphors—W. de Groot. (*Physica*, *'s Grav.*, vol. 7, pp. 432–446; May, 1940. In English, with French and German summaries.) Results are given for periodic illumination of the following substances by intense ultraviolet light: ZnS-Ag, ZnS-Cu, ZnSCdS-Ag, ZnSMnS, $CaWO_4$-Sm, and Zn_2SiO_4-Mn.

535.37:621.385.832 3131

Fluorescent Compounds—(*Electronics*, Buyers' Guide Issue, vol. 21, p. M17; June, 1948.) Colors, luminous efficiencies, and other characteristics are tabulated for various materials used for cathode-ray screens.

535.61-15:621.383.4 3132

Spectral Sensitivity of Lead Telluride Layers—T. S. Moss. (*Nature* (London), vol. 161, pp. 766–767; May 15, 1948.) Curves of relative sensitivity and wavelength are shown for temperatures of 195° K, 90° K and 20° K; the results differ considerably from those obtained by earlier workers. The threshold of sensitivity at 90° K is similar to that for PbSe but the PbTe layers are easier to produce and form efficient infra-red detectors for wavelengths up to 5 or $6\ \mu$ at 20° K.

537.228.1+621.314.63 3133

Crystal—(*Electronics*, Buyers' Guide Issue, vol. 21, pp. M14–M16; June, 1948.) Electrical characteristics of quartz, EDT, and DKT crystals, and of Si, Se, and CuO rectifiers are tabulated or shown graphically.

537.228.1 3134

Compressional Piezoelectric Coefficients of Monoclinic Crystals—H. Jaffe. (*Phys. Rev.*, vol. 73, p. 1467; June, 15, 1948.) Experimental values are given for the coefficients relating to fields parallel to the polar axis. The hydrostatic piezoelectric effect for EDT appears to be much smaller than that derived from Mason's data (740 of April).

537.312.62 3135

Measurements of Radio Frequency Resistance of a Piece of Columbium Nitride through the Transition [from the normal to the superconducting state]—J. V. Lebacqz. (*Phys. Rev.*, vol. 73, p. 1476; June 15, 1948.) The measured values for frequencies between 600 and 1000 kc were the same as the dc values at the same temperatures.

538.221:538.213 3136

On the Dispersion of Initial Permeability—J. L. Snoek. (*Physica*, *'s Grav.*, vol. 7, pp. 515–518; June, 1940. In German, with English summary.) Purified and annealed Fe has an initial permeability, at frequencies of the order of 1 cps, which is many times higher than the value determined from measurements of the skin effect at frequencies of 1 to 100 Mc. Present theories offer no explanation of this.

538.27 3137

The Effect of Premagnetization on the Complex Permeability of Coil Cores—R. Feldtkeller and E. Stegmaier. (*Frequenz*, vol. 2, pp. 121–130; May, 1948.) The laws connecting premagnetization with the complex permeability of Si-Fe and Ni-Fe sheet are reviewed, with particular reference to curves relating the critical value of the complex permeability to the frequency and amplitude of the ac induction. With constant ac induction, premagnetization has an effect on the eddy currents in the material. This effect is explained by the action of the premagnetization on the reversible permeability of the surface layers and of the interior of the sheet.

546.42/.431].82 3138

Barium Titanate and Barium Strontium Titanate Resonators—H. L. Donley. (*RCA Rev.*, vol. 9, pp. 218–228; June, 1948.) Values of the equivalent circuit elements are given for such resonators vibrating normal to the direction of the polarizing and rf fields. An increase in the effective piezoelectric constant with increasing polarizing field is observed. At 25 v/mil an average piezoelectric constant of about 200×10^{-8} electrostatic units, a Q, of 80 and an electromechanical coupling factor of 0.2 are found for $BaTiO_3$ resonators. Lower activity, but higher Q, results with $(Ba/Sr)TiO_3$ resonators. A frequency constant of 211 kc-cm is found for $BaTiO_3$ resonators; for mixtures this rises to 275 kc-cm as the Sr content increases to 30 per cent. The piezoelectric activity ceases as the Curie temperature of a particular composition is approached. A large temperature coefficient of frequency of 1 part in 400 per 1° C limits the use of $BaTiO_3$ for resonators but it compares favorably with Rochelle salt, for use in pickups.

546.431.82:537.228.1/.2 3139

Piezoelectric or Electrostrictive Effect in Barium Titanate Ceramics—W. P. Mason. (*Phys. Rev.*, vol. 73, pp. 1398–1399; June 1, 1948.) Resonance effects in multicrystalline $BaTiO_3$ ceramics are shown to be electrostrictive; they are analogous to magnetostrictive effects in ferromagnetic materials and not to the "quadratic" piezoelectric effect discussed by Mueller (2186 of 1940).

549.623.5(94):621.315.613 3140

Australian Mica—(*Engineering* (London), vol. 165, p. 379; April 16, 1948.) The output of high-grade mica could be increased to 250 tons per year, equivalent to 15 per cent of world production, by provision of improved equipment and amenities for workers.

621.3.015.5:546.217 3141

Electrical Breakdown Strength of Air at Ultra High Frequencies—J. A. Pim. (*Nature* (London), vol. 161, pp. 683–684; May 1, 1948.) A series of experiments in the frequency range 100 to 300 Mc, using cw throughout and an improved method of measuring the rf voltage at the point of breakdown. The relations obtained between the electrical breakdown stress and gap width, frequency and gas pressure suggest that with an alternating field of a particular frequency, some charged particles, probably electrons, are unable to cross the gap before the field is reversed.

621.315.612+666 3142

Ceramics and Glass—(*Electronics*, Buyers' Guide Issue vol. 21, pp. M4–M5; June, 1948.) Electrical, thermal, and mechanical properties are tabulated for various materials, with brief remarks about each.

621.315.615 3143

A Brief Outline of Insulating Oil Problems—E. S. Lane. (*Distrib. Elec.*, vol. 20, pp. 337–338; April, 1948.) Summary of paper read at an Australian Electricity Supply Engineers' Association conference. The presence of oxygen causes acidity and sludging. Oxidation can be reduced by using inert gases, silica-gel, or conservators.

621.315.616:533.5 3144

Vacuum Properties of Synthetic Dielectrics—B. G. Hogg and H. E. Duckworth.

(*Rev. Sci. Instr.*, vol. 19, pp. 331–332; May, 1948.) Wide differences of vapor pressure are found in vacuum tests on 28 commercial materials. Many of these, such as polystyrene, teflon, and mycalex, are particularly suitable for use in vacuum systems.

621.315.616:678 3145

Rubber Dielectrics—Some Chemical Aspects—B. B. Evans. (*Distrib. Elec.*, vol. 21, pp. 2–6; July, 1948.) Qualitative accelerated aging tests for the study of rubber dielectric deterioration are described. Vulcanizing processes are hastened by the use of organic accelerators, the desirable properties of which are discussed. Life can be increased by incorporating small amounts of "anti-oxygen" or "disactivator" materials.

621.318.22+621.318.32 3146

Magnetic Materials—(*Electronics*, Buyers' Guide Issue, vol. 21, pp. M20–M23; June, 1948. Characteristics are tabulated for materials used for laminated, solid, and powdered metal cores and for permanent magnets.

621.383 3147

On the Absorption, Light Sensitivity and Electrical Conductivity of CdS Layers—K. Weiss. (*Z. Naturf.*, vol. 2a, pp. 650-652; November and December, 1947). A short review of the properties of layers produced by a particular process. The sensitivity is 10^{-2}A/lumen and a light power of 10^{-10}w can be detected. Completely insulating layers of CdS, PbS and Sb_2S_3 have been produced.

621.383:546.817.221 3148

On the Effect of Gases, particularly of Traces of Oxygen, on the Electrical Properties of Evaporated PbS Layers—H. Hinterberger. (*Z. Naturf.*, vol. 1, pp. 13–17; January, 1946.) An investigation of the effect of N, Ar, O, H, and air. N and Ar have no effect, but air and especially small traces of O have a marked effect, which is qualitatively the same as that of a sulphur treatment. Tempering in H increases the conductivity of PbS layers with excess Pb.

621.395.625.3 3149

Test Characteristics of Recording Wire—G. S. Carter and R. Koontz. (*Tele-Tech*, vol. 7, part 1, pp. 38–40, 75; May, 1948.)

669 3150

Metals and Alloys—(*Electronics*, Buyers' Guide Issue, vol. 21, pp. M24–M29; June, 1948.) Brief details of various compositions used for solders, resistors, switches and contacts, thermocouples, and tube parts.

678.72 3151

New Synthetic Rubber Has High Oil and Heat Resistance—(*Materials and Methods*, vol. 27, pp. 72–74; June, 1948.) Discussion of a polyacrylic ester, commercially named Hycar P.A., which withstands dry heat to 400° F, has excellent resistance to deterioration by oils or sunlight, forms a good gas barrier and has a good flex life. Methods of preparing cured varities of varying hardness are described. The relative merits of Hycar P.A., Lactoprene EV and styrene rubber GR-S are discussed.

679.5 3152

Plastics—(*Electronics*, Buyers' Guide Issue, vol. 21, pp. M30–M35; June, 1948.) Electrical and mechanical properties of moulding and casting compounds, laminated materials, and synthetic and natural rubbers.

679.5:620.193 3153

The Effect of Fungi and Humidity on Plastics—J. Leutritz, Jr. (*ASTM Bull.*, pp. 88–90; May, 1948.) Discussion of experimental results for various materials exposed to tropical conditions. Fungus without moisture is a fairly good insulator. Elimination or mitigation of moisture difficulties will automatically control fungus and reduce insulation failures.

679.5:621:397.5:535.88 3154

Plastic Lenses in Television Projection—D. Starkie. (*Jour. Telev. Soc.*, vol. 5, pp. 86–92; September, 1947. Discussion, p. 93.) The properties of suitable plastic optical materials are discussed, and a method of manufacturing lenses by a "surface-finishing" process is described. A preform plastic optical component is first moulded, using light polymerization. The preform is removed from the mould and annealed. Any departures from the form of the mould found after the annealing are corrected by casting a thin film of polymer on the surface of the preform.

679.5:621.793 3155

Metal-Coated Plastics Combine Advantages of Both Materials—H. R. Clauser. (*Materials and Methods*, vol. 27, pp. 79–82; June, 1948.) Metal coatings can be applied by electro-plating, vacuum evaporation or metal spraying. The relative merits of these methods are discussed, and various practical applications are mentioned. See also 2544 of October (Narcus).

679.5:681.42 3156

Plastics as Optical Materials—H. R. Moulton. (*ASTM Bull.*, pp. 75–77; March, 1948. Discussion, p. 77.) Discussion of: (a) properties of optical materials, (b) the relative merits of glass and plastics, (c) methods of processing plastics, (d) future possibilities of using complex mixtures.

533.5 3157

A Manual of Vacuum Practice [Book Review]—L. H. Martin and R. D. Hill. Melbourne University Press, Melbourne; Oxford University Press, London; 1947. 120 pp., 10s.6d., (*Nature* (London, vol. 161, p. 665; May 1, 1948.) "An excellent addition to the all too few modern books in the English language on vacuum technique . . . the commercial apparatus referred to in the text includes both English and American types of the most modern pattern."

MATHEMATICS

517.392:621.396.67 3158

Concerning a New Transcendent, its Tabulation and Application in Antenna Theory—C. J. Bouwkamp. (*Quart. Appl. Math.*, vol. 5, pp. 394–402; January, 1948.) Some of the features of the function

$$E_1(z)=\int_0^1(1-e^{-izst})ds\ dt/st$$

are discussed with particular reference to Hallen's antenna theory. A short table of numerical values is given.

517.512.2:621.396.67 3159

Fourier Transforms in Aerial Theory: Part 6—J. F. Ramsay. (*Marconi Rev.*, vol. 11, pp. 45–50; April to June, 1948.) Conclusion of 2270 of September. The earlier parts are summarized and further developments indicated. A classified bibliography of 82 references is included.

518.5 3160

The Univac—(*Electronic Ind.*, vol. 2, pp. 9, 19; May, 1948.) Summary of IRE 1948 Convention paper noted in 2548 of October. A short description of a high-speed electronic digital computer. The method of storing 1000 12-digit numbers as supersonic pulses in Hg columns is described. Magnetic tape recording is used to pass controling instructions and data to and from the computer. Possible applications varying from the solution of integral and partial differential equations to the classification of statistical information are discussed.

518.5 3161

Compact Analog Computer—S. Frost. (*Electronics*, vol. 21, pp. 116–122; July, 1948.) A technical description of the Reeves Electronic Analog Computer (REAC) together with circuit diagrams and photographs. The REAC comprises a computer unit, servomechanism unit, recorder unit, and associated power supplies. Solutions of both linear and nonlinear simultaneous differential equations, such as occur in design engineering, can be readily obtained.

518.61:621.396.611.1 3162

The Escalator Process for the Solution of Damped Lagrangian Frequency Equations—J. Morris. (*Phil. Mag.*, vol. 38, pp. 275–287; April, 1947.) Extension of 1636 of 1945 (Morris and Head) to equations of the Lagrangian type in which each element is a polynomial instead of merely a linear function of the unknown latent root. The "modes" of such equations have orthogonal properties analogous to those for ordinary Lagrangian frequency equations. See also 2167 of 1947.

518.61:621.396.611.1:512.831 3163

Note on the Morris Escalator Process for the Solution of Linear Simultaneous Equations—R. A. Frazer. (*Phil. Mag.*, vol. 38, pp. 287–289; April, 1947.) The process described in 463 of 1947 (Morris) is here expressed in matrix form. See also 3162 above.

519.27:530.16 3164

Distribution of the Sum of Randomly Phased Components—W. R. Bennett. (*Quart. Appl. Math.*, vol. 5, pp. 385–393; January, 1948.) A method of finding the distribution of the sum of n vectors with given moduli and randomly distributed arguments for values of n of the order of 10. A convergent Fourier-Bessel series is derived. The special case where all the vectors have equal moduli is used to illustrate the method, which is later extended to the general case. The envelope of a group of sine waves is discussed briefly.

MEASUREMENTS AND TEST GEAR

531.761 3165

A Portable Electronic Chronometer—G. T. Baker. (*Jour. Sci. Instr.*, vol. 25, pp. 194–198; June, 1948.) A crystal-controlled chronometer, which measures intervals up to 1 sec with an accuracy of 0.1 ms and can be used by a semiskilled operator for measuring circuit transients, operation times of relays, etc.

621.3.018.4(083.74) 3166

Two Portable Substandards of Frequency—R. Terlecki and J. W. Whitehead. (*Jour. Sci. Instr.*, vol. 25, pp. 237–239; July, 1948.) Details of two instruments, using crystal-controlled multivibrators, which give spot frequencies (a) 10 kc, (b) 1 kc apart over the range 10 kc to 35 Mc. Check points are available at intervals of 1 Mc and 5 Mc and in the second instrument the output may be modulated.

621.3.018.4(083.74) 3167

Portable Crystal-Controlled Frequency Standard—R. I. B. Cooper. (*Elec. Commun.*, vol. 25, pp. 30–34; March, 1948.) Illustrations and performance details of a substandard using a 100-kc GT-cut crystal with plated electrodes, mounted in an evacuated bulb.

621.317.3:621.392.029.64 3168

On the Representation and Measurement of Waveguide Discontinuities—Marcuvitz. (*See* 3020.)

621.317.3.011.5 3169

The Plate Method for Determining Dielectric Constants and Loss Angles—I. A. El'tsin. (*Zh. Tekh. Fiz.*, vol. 18, pp. 657–664; May, 1948. In Russian.) A rigorous theory is given of a method in which a thin plate of the material under investigation is placed at the middle of a tuned Lecher system. Formulas are derived for calculating, from measurements at λ 3.36 m, the dielectric constants and loss angles for various solid dielectrics.

621.317.336 3170

Accuracy of Impedance Measurements—B. Secker. (*Elec. Commun.*, vol. 25, pp. 74–83; March, 1948.) Impedance-unbalance and precise impedance measurement systems are considered. Sources of errors in bridges of various types are discussed and comparisons made between different bridges for particular measurements. Curves show the limits of measurement of series- and parallel-resonance bridges; the fundamental balance conditions for different types of bridge are derived.

621.317.35 3171

A New Method in the Analysis of Complex Electric Waves—W. E. Rogers (*Rev. Sci. Instr.*, vol. 19, pp. 332–335; May, 1948.) A potentiometer method for direct measurement of the phase and amplitude of the harmonic components of complex waves. A known complex wave form having a periodic relationship with the wave to be analyzed is used as a reference and both waves are fed to a tunable, frequency-selective detector which acts as a null indicator. Comparison is made by adjusting the amplitude and phase of the reference wave.

621.317.44:538.632:546:289 3172

A Magnetic Field Strength Meter Employing the Hall Effect in Germanium—G. L. Pearson. (*Rev. Sci. Instr.*, vol. 19, pp. 263–265; April, 1948.) The essential components include a small Ge probe and a microammeter which is calibrated directly in gauss. Accuracy is within 2 per cent for fields between 100 and 8000 gauss. At higher field strengths the readings are too low, the error being about 9 per cent at 20,000 gauss. Advantages are (a) small size and portability, (b) steady reading, (c) small nonmagnetic probe which can be used in very narrow gaps.

621.317.7 3173

New Long-Scale Instruments—R. M. Rowell and N. P. Millar. (*Gen. Elec. Rev.*, vol. 51, pp. 14–19; April, 1948.) Construction details of dc and ac ammeters and voltmeters, wattmeters, power-factor meters, and frequency meters with pointer movement of 250°.

621.317.715 3174

The Construction of Micro-Galvanometer Systems—A. C. Downing. (*Jour. Sci. Instr.*, vol. 25, pp. 230–231; July, 1948.) Systems of period 0.01 second, resistance 20Ω, 0.3 to 0.5 mm wide and weighing 3 to 5 mg are described, with methods of winding and inserting connecting tags. See also 3175 below.

621.317.715 3175

Moving-Coil Galvanometers of Short Period and their Amplification—A. V. Hill. (*Jour. Sci. Instr.*, vol. 25, pp. 225–229; July, 1948.) The design and performance of a short-period galvanometer and photoelectric amplifier are discussed. Potential changes of a few microvolts in a low-resistance circuit can be measured to within 0.5 per cent. See also 3174 above.

621.317.72:621.392.43 3176

A Modified Micromatch—D. N. Corfield and C. W. Cragg. (*RSGB Bull.*, vol. 23, pp. 211–213; May, 1948.) An instrument similar to that described in 2853 and 3188 of 1947 (Jones and Sontheimer) but suitable for use at frequencies up to 60 Mc. Details of its construction and operation, and the selection of suitable components, are discussed.

621.317.723 3177

An Electrometer Tube Amplifier Circuit—E. Lindholm and E. Hullegård. (*Ark. Mat. Astr. Fys.*, vol. 34, part 4, section B, 5 pp.; April 13, 1948. In English.) A 2-tube circuit which gives high stability and uses ordinary T114 tubes. The same battery is used for filament current and anode voltage.

621.317.725 3178

Valve Voltmeter and Galvanometer with D.C. Amplifier—R. L. Schupp and R. Mecke. (*Funk und Ton*, vol. 2, pp. 285–289; June, 1948.) A 3-stage amplifier with push-pull output stage is described which uses two Type EDD11 double triodes. Stabilized supply voltages give good zero stability. With a 4000-Ω output meter the voltage sensitivity is 0.1 mv.

621.317.729:537.58:621.385.1 3179

Representation in the Electrolyte Tank of the Effect of Space Charge in Valves—R. Musson-Genon. (*Onde Élec.*, vol. 28, pp. 236–242; June, 1948.) An account of a method for determining the distribution of potential, taking account of the space charge $\Delta U_{(x,y)} = -4\pi\rho$. The bottom of the tank is suitably contoured. The method involves successive approximations which converge very rapidly, it can be extended to the study of the functions $\Delta\phi_{(x,y)} = f(x, y, \phi, \ldots)$. Examples of its use are given.

621.317.733 3180

Remarks on A. C. Wheatstone Bridges—F. Perrier. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1806–1808; May 31, 1948.) Simple theory shows that maximum sensitivity is obtained when the bridge arm between the source and the impedance *Z* to be measured consists of an impedance whose modulus is equal to that of *Z* and whose argument differs from that of *Z* as much as possible.

621.317.733 3181

Capacitance Bridge with Mechanical Rectifier and Moving-Coil Galvanometer as Indicator—F. Koppelmann. (*Frequenz*, vol. 2, pp. 100–105; April, 1948.) Theory and description of a practical bridge of the Schering type. A mirror galvanometer gives greater sensitivity than is obtained with a vibration galvanometer as indicator. A disadvantage is the sensitivity to harmonics. The disturbing effect of any single harmonic can be eliminated by adjustment of the rectifier contacts, but other harmonics may still mask the balance to some extent.

621.317.738 3182

Capacitance Meter with Neon-Lamp Indicator—L. Grillet. (*Compt. Rend. Acad. Sci.* (Paris), vol. 226, pp. 1968–1969; June 14, 1948.) Details of a method particularly suitable for the comparison of capacitances less than 1000 pF. The resistor usually fitted in the neon lamp socket is removed and the lamp then serves as a very sensitive current indicator, becoming luminous for currents much less than 1 μamp.

621.317.75.015.3:621.395.625.6 3183

Sweeping Device for the Display of Transient Phenomena and Nonlinear Distortion—W. Meyer-Eppler. (*Arch. Elek.* (Übertragung), vol. 2, pp. 1–14; January, 1948.) A photomechanical projection apparatus for either visual observation or photographic recording, and particularly suitable for use with sound films. See also 2854 of 1942.

621.317.755 3184

Multigun C.R. Oscillography—H. S. Bamford. (*Electronic Ind.*, vol. 2, pp. 10–13; May, 1948.) A description of cathode-ray tubes having up to ten complete gun and deflecting systems mounted inside the same envelope. The methods of shielding each assembly and connecting the deflecting plates by short leads to terminals spaced round the neck of the tube are illustrated. Individual assemblies can have either standard orthogonal deflecting systems or a radial deflecting system with two conical electrodes. Possible applications in the fields of bio-electricity and color television are discussed.

621.317.755:531.767 3185

Measurement of [c.r.] Spot Trace Speed—C. Besle. (*Rev. Gén. Élec.*, vol. 57, pp. 189–192; May, 1948.) A method is described in which the spot is made to describe a spiral with constant angular velocity. The maximum recording speed is found by noting, on the photographic record of the spiral, the point where the spot ceases to be visible.

621.317.761 3186

Direct-Reading Superheterodyne Frequency Meter—L. M. Berman. (*Toute la Radio*, vol. 15, pp. 176–178; June, 1948.) Details of an instrument, constructed by the Laboratoires Radioélectriques, which has definite advantages as regards both sensitivity and selectivity over wavemeters using direct amplification. Ranges are 550 kc to 5 Mc and 5 Mc to 30 Mc. The absolute accuracy of the quartz crystal reference frequency is within 1 part in 10^6 and the possible error in reading the difference frequency directly can be reduced to 1 cps. A signal can be measured in the presence of an interfering signal of equal strength only 100 cps away. If the interfering signal is about 50 times as strong as the signal to be measured, a separation of 400 cps is necessary.

621.317.761:621.385.38 3187

Study of the Discharge of a Capacitor through a Thyratron. Application to the Study of the Operation of a Direct-Reading Valve Frequency Meter—R. Legros. (*Rev. Gén. Élec.*, vol. 57, pp. 193–200; May, 1948.) The operational characteristics of thyratrons are reviewed; graphs show the theoretical variations of thyratron current and voltage during the discharge. An expression is derived for the mean current registered by a thyratron/capacitor type of frequency meter. Experimental data are in agreement with theory.

621.317.78 3188

Method of Measuring H.F. Power—L. Liot. (*Radio Franç.*, pp. 21–25; May, 1948.) Two methods are described, one using lamps with short straight filaments, the other using thermojunctions. One lamp is connected to a voltage source derived from the circuit to be measured; the second is fed from a dc source, which is adjusted till the two filaments are equally bright. An accuracy within about 10 per cent can be obtained at frequencies up to 1000 Mc for mean powers of about 20w. The thermojunction method gives comparable results up to frequencies of the order of 300 Mc.

621.317.79:621.396.822 3189

A Noise Meter for Broadcasting Stations—M. A. Slutsker and M. A. Studitski. (*Vestnik Svyazi*, no. 6, pp. 12–13; 1948. In Russian.)

621.317.79:621.396.97 3190

CBS Transmission Measuring Set—D. F. Maxwell. (*Audio Eng.*, vol. 32, pp. 16–19, 46; April, 1948.) A new instrument designed for precision af testing in broadcast service. The set is a combination of calibrated attenuators, matching devices, and power-level indicators. Response/frequency measurements are accurate to within 0.1 db. Input and output power levels are given to within 0.2 db.

621.396.615.17 3191

A Precision Double-Pulse Generator—D. J. Medley and H. D. Rathgeber. (*Jour. Sci. Inst.*, vol. 25, pp. 234–236; July, 1948.) Description of an instrument for producing either single or repeated pairs of electrical pulses, similar to Geiger-counter discharges, separated by a time interval which is continuously adjustable from 0 to 74 μ seconds.

621.396.822:621.385.2 3192

[Diode] Noise Generator for Receiver Measurements—P. G. Sulzer. (*Electronics*, vol. 21, pp. 96–98; July, 1948.) The receiver bandwidth need not be known and measurement is independent of the response curve of the receiver.

621.396.822:621.396.621 3193

The Estimation and Measurement of the Sensitivity of Radio Receivers in Terms of kT Units—Slepyan. (*See* 3232.)

621.317.79:621.396.615 3194

Test Gear for Frequency Modulation and Television [Book Notice]—B.I.O.S. Final Report No. 1269 and addendum. H.M. Stationery Office, London, February 6, 1947, 22 and 3 pp., 3s.6d. and 1s. Signal generators were the only forms of test equipment designed in Germany specifically for FM; they were conventional in design, as were the methods of modulation and demodulation. The addendum describes a test oscillator which may be swept cyclically over three frequency bands (0 to 8, 6 to 14, and 12 to 20 Mc) in order to measure the if characteristics of television receivers, the frequency response being displayed on a cathode-ray tube.

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

534.321.9.001.8:614.8 3195

Notes on Using High-Power Ultrasonics—S. Y. White. (*Audio Eng.*, vol. 32, pp. 26–27, 37; April, 1948.) Discussion of possible dangers to health in high-intensity ultrasonic fields, and of the conditions necessary for ultrasonic coagulation of fine particles in air.

535.33:535.61-15 3196

Electronic Eyepiece for Spectroscopy of Near Infra-Red—Z. V. Harvalik. (*Rev. Sci. Instr.*, vol. 19, pp. 254–257; April, 1948.)

539.16.08 3197

Self-Quenching Halogen-Filled Counters—S. H. Liebson and H. Friedman. (*Rev. Sci. Instr.*, vol. 19, pp. 303–306; May, 1948.) Counters filled with inert gases containing small amounts of one of the halogens are selfquenching and have an apparently unlimited life. Their characteristics are similar to those of counters with argon-alcohol filling.

539.16.08 3198

The Effect of the Composition of the Gas Mixture in Self-Quenching Geiger-Müller Tubes on Their Plateau Characteristics—S. J. du Toit. (*Phys. Rev.*, vol. 73, p. 1473; June 15, 1948.)

59.16.08 3199

Geometric Factors Underlying Coincidence Counting with Geiger Counters—H. E. Newell, Jr. (*Rev. Sci. Instr.*, vol. 19, pp. 384–389; June, 1948.) The coincidence rate of a perfectly efficient 2-counter telescope embedded in an isotropic field of radiation is obtained in terms of the radiation intensity and the effective dimensions and separation of the two counters. The formulas determine the counting rate within limits which in most practical cases differ by only a few per cent.

539.16.08 3200

Characteristics of the Parallel-Plate Counter—L. Madansky and R. W. Pidd. (*Phys. Rev.*, vol. 73, pp. 1215–1216; May 15, 1948.)

615.84:616.853 3201

The Electroshock—B. Roger. (*Radio Franç.*, pp. 37–40; May, 1948.) Some details of apparatus for producing shocks of various intensities for therapeutic purposes, particularly the treatment of epilepsy.

621.365:621.385.1 3202

Tube Trends in Field of Industrial Heating—Doolittle and Steinberg. (*See* 3278.)

621.38.001.8:786.6 3203

Design of Electronic Organs: Part 3—W. Wells. (*Audio Eng.*, vol. 32, pp. 24–25, 40; April, 1948.) A detailed discussion of the Hammond organ. The tone generator assembly contains 91 phonic wheels, gear-driven from a synchronous motor operated from ac mains, so that the instrument is always in tune. Manual and pedal contact troubles are avoided by using Pt-Ir and Pd for the switch contacts. The switch assembly is sealed in a metal housing, and requires neither cleaning nor adjustment. Novel tone controls are provided for addition of harmonics. See also 2583 of October (Long).

621.384.6+538.56+621.385.029.63/.64 3204

Waves and Electrons Traveling Together—A Comparison between Traveling Wave Tubes and Linear Accelerators—Brillouin. (*See* 3093.)

621.384.6 3205

Effect of the Electron Beam on the Voltage Distribution of a High-Voltage Multi-Stage Electron Accelerator—F. W. Waterton. (*Nature* (London), vol. 161, pp. 563–564; April 10, 1948.)

621.384.6 3206

A New Method for Displacing the Electron Beam in a Betatron (Synchrotron)—R. Wideröe. (*Rev. Sci. Instr.*, vol. 19, pp. 401–402; June, 1948.) Description of a method proposed in 1945 similar to that described in 832 of 1947 (Clark, Getting, and Thomas), and of an improvement designed to reduce orbital instability.

621.384.6 3207

Investigations on a 15-MeV Betatron—R. Kollath and G. Schumann. (*Z. Naturf.*, vol. 2a, pp. 634–642; November and December, 1947.) An account of its construction and operation, and of tests regarding its X-ray output.

621.385.833 3208

Summarized Proceedings of Conference on Electron Microscopy—Leeds, September, 1947—V. E. Cosslett. (*Jour. Sci. Instr.*, vol. 25, pp. 167–170; May, 1948.) Discussion of (a) biological applications, (b) new instruments and technical methods. See also 1713 of July (Reed).

621.385.833 3209

The French Electrostatic Microscope—P. Grivet. (*Ann. Radioélec.*, vol. 3, pp. 144–145; April, 1948.) A review of its development and of relevant theory.

621.385.833:535.317.25 3210

A New Microscopic Principle—D. Gabor (*Nature* (London), vol. 161, pp. 777–778; May 15, 1948.) A note giving a broad explanation of the principle which may enable the resolving power of electron microscopes, at present limited by spherical aberration, to be increased by dispensing with the objective. Micrographs are obtained by electronic analysis followed by optical synthesis. The principle is used in the "X-ray microscope," but can be applied much more generally. It has been tested by means of an optical model.

621.391.63:526.9 3211

Surveying with Pulsed-Light Radar—W. W. Hansen. (*Electronics*, vol. 21, pp. 76–79; July, 1948.) An adaptation of radar techniques for surveying over inaccessible terrain. Light pulses from a flash lamp at one site are reflected back from the remote site by a system of mirrors. The reflected pulses operate a photo cell and produce pips on the trace of a cro. Distances and angles can be measured with an accuracy comparable to that of a third-class survey.

621.396.9 3212

Apparatus for Finding Pieces of Iron in Timber—J. Hacks. (*Z. Angew. Phys.*, vol. 1, pp. 11–19; January, 1948.) A permanent magnet carrying a multiturn search coil and compensating coil is used. Any iron near the search coil causes a variation in the pitch of the note given by an audio beat-frequency generator. A 2-cm shot can be detected at a distance of 25 cm and a 2-mm iron nut at 5.5 cm.

PROPAGATION OF WAVES

538.566 3213

Calculation of the Potential from the Asymptotic Phase—C. E. Fröberg. (*Ark. Mat. Astr. Fys.*, vol. 34, part 4, section A, 16 pp.; April 13, 1948. In English.) Full paper. Summary abstracted in 223 of February.

621.396.11 3214

Investigations on Short-Wave Echo Signals: Part 1—H. A. Hess. (*Z. Naturf.*, vol. 1, pp. 499–505; September, 1946.) Measurements for frequencies in the range 10 to 20 Mc give a value of 0.137788 second for the time of travel round the earth. This value appears to be independent of frequency, time of day and time of year, and for distances of over 1000 km gives distances correct to within about 25 km. The results in general favor the theory of guided propagation and not the theory of zigzag reflection between the ionosphere and earth. For part 2 see 3215 below. See also 2889 of November.

621.396.11 3215

Investigations on Short-Wave Echo Signals: Part 2—H. A. Hess. (*Z. Naturf.*, vol. 2a, pp. 528–534; September, 1947.) An account of investigations for distances between transmitter and receiver less than 1000 km, where multipath effects are pronounced. These may give rise to path time differences of several milliseconds. The strength of the interfering echoes was found to depend on the directional characteristics of the receiving antenna and on the polarization of the incoming waves. The results are discussed. Part 1: 3214 above.

621.396.11 3216

Long-Distance Propagation of Short Waves—L. Hamberger and K. Rawer: H. A. Hess. (*Z. Naturf.*, vol. 2a, pp. 521–527; September, 1947.) Hamberger and Rawer consider that the approximate constancy of the time taken for short-wave propagation right round the earth can be explained, contrary to the views of Hess (3214 above), by zigzag reflection between the ionosphere and the earth. The values given by Hess would correspond to 12 to 17 reflections.

Hess points out that the observed angle of arrival of waves which have traveled round the earth does not favor the zigzag reflection theory.

621.396.11:523.746 3217

Sunspots and Radio Weather—Arzinger, Hallborg, and Nelson. (*See* 3106.)

621.396.11:551.510.535 3218

Upper-Atmosphere Circulation as Indicated by Drifting and Dissipation of Intense Sporadic-E Clouds—Ferrell. (*See* 3117.)

621.396.11:551.510.535 3219

A Study of the Interaction of Radio Waves—J. A. Ratcliffe and I. J. Shaw. (*Proc. Roy. Soc. A*, vol. 193, pp. 311–343; July 2, 1948.) Experiments have been carried out to provide information about the mechanism by which modulation can be transferred from one wave to another during transmission through the ionosphere. Earlier theories, indicating that this phenomenon is due to nonlinear absorption, are restated in current nomenclature and are shown to be confirmed by the experimental data. The results provide a measure of the heights at which absorption takes place at different frequencies and of the electron collision frequency in the absorbing regions.

621.396.11:551.510.535 3220

Restricted-Range Sky-Wave Transmission—J. E. Hacke, Jr., and A. H. Waynick. (Proc. I.R.E., vol. 36, pp. 787–793; June, 1948.) 2.4-Mc signals from an omnidirectional antenna can normally be received by reflection from the *E* layer at ranges up to 2000 km. By designing an antenna array to give increased vertical directivity, the maximum range can be reduced to 500 km. The limitations and advantages of the system are discussed.

621.396.11:551.510.535 3221

Triple Splitting of Ionospheric Rays—J. H. Meek. (*Nature* (London), vol. 161, p. 597; April 17, 1948.) The theory of ionospheric reflection of medium-frequency and high-frequency radio waves at vertical incidence indicates the existence of a triple splitting effect in polar regions, due to the nearly vertical magnetic field of the earth. In Canada a complete trace is often seen extending from the *E* region through the F_1 region to the F_2 region. A sample record is given showing observed characteristics of the third split. See also 3222 below.

621.396.11:551.510.535 3222

Triple Splitting of Ionospheric Rays—T. L. Eckersley. (*Nature* (London), vol. 161, pp. 597–598; April 17, 1948.) The triple splitting of rays reflected from the *F* region is thought, on the basis of the observed polarization, to be due to coupling between the ordinary and extraordinary rays. See also 2595 of October (Newstead) and 3221 above.

621.396.812 3223

On the Wave-Guiding Properties of Non-Uniform Media—P. E. Krasnushkin. (*Zh. Tekh. Fiz.*, vol. 18, pp. 431–446; April, 1948. In Russian.) By using the method of normal modes, a complete picture of the wave propagation beyond the horizon in the case of a nonuniform troposphere and ionosphere can be given. The method consists in representing the wave field in the form of a spectrum of normal modes, the discontinuous portion of which is analogous to the spectrum of normal waves in a hollow pipe. An exact solution of the problem is given for the case of a plane multiplayer medium and an approximate solution for the case of a spherical multilayer medium. See also 516 of 1947 (Booker), 2892 of 1947 (Booker and Walkinshaw) and 2211 of 1947 and 224 of February (Pekeris).

621.397.812.029.62/.63 3224

Comparative Propagation Measurements: Television Transmitters at 67.25, 288, 510, and 910 Megacycles—G. H. Brown, J. Epstein, and D. W. Peterson. (*RCA Rev.*, vol. 9, pp. 177–201; June, 1948.) The transmitting antennas were near to or at the top of the Empire State Building. Two 50-mile paths were chosen, one over hilly terrain with maximum elevation 1200 feet and the other over fairly flat terrain with no hills above 230 feet. The receiver antennas were mobile, and 30 feet above ground. Measurements were made at 2-mile intervals along each path.

Theoretical and experimental field-strength values agreed more closely for the flat path than the hilly one, and more closely for 67.25 Mc than for 288 Mc. The field strengths for 510 and 910 Mc were usually far below the theoretical values.

Shadowing from obstacles increased steadily with frequency and was severe at 910 Mc. Curves are given from which television transmitter power requirements can be estimated for different frequencies.

Multipath effects were slight at 67.25 and 288 Mc, but severe in obstructed areas at 510 and 910 Mc. A clean picture could usually be obtained by suitable orientation of the receiver antenna.

621.396.812.029.64 3225

Results of Horizontal Microwave Angle-of-Arrival Measurements by the Phase-Difference Method—A. W. Straiton and J. R. Gerhardt. (Proc. I.R.E., vol. 36, pp. 916–922; July, 1948.) The measurements were made on λ 3.2 cm over a 7-mile path lying along a shore line in the Gulf of Mexico. Small deviations of the angle of arrival (of the order of 0.02°) in a a landward direction from the geometric path were very frequently noted. Meteorological soundings showed overwater ducts to be present nearly all the time and there was a general correlation between the angular deviations and the horizontal gradient of radio refractive index. See also 1182 of 1947 (Sharpless) and 1183 of 1947 (Crawford and Sharpless).

621.396.11:551.510.535 3226

Radio Research Special Report No. 17. Fundamental Principles of Ionospheric Transmission [Book Notice]—H. M. Stationery Office, 1s.6d. (*Govt. Publ.* (London), p. 18; June, 1948.) Joint publication of the Department of Scientific and Industrial Research and the Admiralty.

RECEPTION

621.396.621 3227

Converting the 1147B for 50–250 Mc/s Operation—B. W. St. L. Montague. (*RSGB Bull.*, vol. 23, pp. 214–216, 218; May, 1948.) Details of the necessary modifications of the RAF receiver R.1147 B, which include rewinding the if transformers and oscillator coils. Provision is made for the addition of an FM discriminator, which will be described later.

621.396.621 3228

The Marconi High Discrimination Communication Receiver, Type R.G. 44—L. R. Mullin. (*Marconi Rev.*, vol. 11, pp. 33–38; April to June, 1948.) A receiver designed for war-time mass production. The printed tuning scale forms a spiral on a drum, and is calibrated at 10-kc intervals between 2 and 20 Mc. Mechanical and electrical features are discussed, including methods of temperature compensation for the oscillator and an avc system having improved noise characteristics.

621.396.621 3229

A High-Fidelity Receiver—L. Chrétien. (*TSF Pour Tous*, vol. 24, pp. 84–86, 127–129, and 152–154; April to June, 1948.) Continuation of 2336 of September. Discusses high-frequency amplification, coupling circuits, and frequency changing.

621.396.621 3230

Single-Signal Single-Sideband Adaptor—E. W. Rosentreter. (*Electronics*, vol. 21, pp. 124, 143; July, 1948.) Full circuit details are given for the General Electric single-sideband selector. Principles of operation are discussed, with reference to the work of Villard (2597 of October) and Dome (1021 of 1947). The selector unit is connected to the last if stage of an existing AM receiver by means of a small probe and a short length of low-capacitance shielded cable.

621.396.621:06.064 Paris 3231

French Receiver Construction at the Paris Fair, 1948—G. Giniaux and J. Rousseau. (*TSF Pour Tous*, vol. 24, pp. 159–164; June, 1948.) A general account, with a table giving particulars of about 130 receivers, and also a discussion of receivers with special characteristics.

621.396.621:621.396.822 3232

The Estimation and Measurement of the Sensitivity of Radio Receivers in Terms of kT Units—L. B. Slepyan. (*Radiotekhnika* (Moscow), vol. 3, pp. 3–10; March and April, 1948. In Russian.) Starting from the well-known Nyquist formula (1) determining the signal level in an equivalent antenna circuit necessary for producing the same effect at the output of the receiver as that due to noise originating in it, formulas are derived for calculating the sensitivity of a receiver in kT energy units, k being Boltmann's constant and T the absolute temperature. The difference between the coefficient of insensitivity D (formula 10) and noise factor F (formula 12) is established and methods are indicated for measuring them. See also 1656 and 2337 of 1942 (North).

621.396.621.53:621.385.2 3233

The Fundamental Relationships in the Diode Frequency Changer—L. S. Gutkin. (*Zh. Tekh. Fiz.*, vol. 18, pp. 615–638; May, 1948. In Russian.) A theoretical analysis of a diode mixer stage is given, neglecting the effects of parasitic inductance, capacitance, etc. The various relationships determining the operation of the stage are derived and conditions are established for obtaining the maximum amplification when the diode is loaded with one- or two-section filters. The effect of noise is investigated in detail. Formulas derived by Strutt (1573 of 1947) are criticized.

621.396.621.54:621.316.72 3234

On the Automatic Stabilization of the Amplification of a Superregenerative Receiver for the Reception of Pulse Signals—M. K. Belkin. (*Radiotekhnika* (Moscow), vol. 3, pp. 25–35; May and June, 1948. In Russian.) The theory of the receiver is discussed and the necessity of automatic stabilization is pointed out. The total amplification N of the receiver is equal to $N_p\eta$ where N_p is the gain due to regeneration and η the gain given by superregeneration as compared to regeneration. An experimental investigation in which stabilization of the receiver was effected by controlling N_p or η is discussed. The second method is preferable but neither method is quite satisfactory. It is suggested that stabilization within the circuit of the receiver should be combined with that of the power supplies.

621.396.622 3235

Theory of Frequency Counting and Its Application to the Detection of Frequency-Modulated Waves—É. Labin. (Proc. I.R.E., vol. 36, pp. 828–839; July, 1948.) A theoreitcal study of the operation of electronic circuits which produce an output proportional to the frequency of the input signal. If the input signal is modulated, the output should reproduce the modulation. As a detector, the frequency counter has low over-all sensitivity, but this appears to be unimportant; it is much more rugged than ordinary "differential" discriminators, and does not require close tolerances, or adjustment when installed in a receiver.

621.396.662 3236

The Browning RV-10 F.M. Tuner—F. A. Spindell. (*FM and Telev.*, vol. 8, pp. 37–40, 59; May, 1948.) Circuit details, performance characteristics and alignment procedure for a straight tuner using the Armstrong circuit.

621.396.82 3237

Interference between Very-High-Frequency Radio Communication Circuits—W. R. Young, Jr. (Proc. I.R.E., vol. 36, pp. 923–930; July, 1948.) Various common causes of interference are discussed and sample measurements are quoted to illustrate their relative magnitudes. Formulas are given for computing the frequency of the disturbances. A method is described for making charts, suitable for a given type of equipment, from which spurious frequencies can be read directly as a function of the operating frequency.

621.396.822 3238

Some General Results in the Theory of Noise through Non-Linear Devices—D. Middleton. (*Quart. Appl. Math.*, vol. 5, pp. 445–498; January, 1948.) The Fourier series method of Rice (2169 of 1945 and back references) is applied to the following unsolved problems; (a) Passage of a modulaated signal in the presence of noise through a general nonlinear apparatus, with a sinusoidally modulated carrier, or with narrow-band noise, symmetrically distributed in frequency about the carrier. (b) The biased μ th-law rectifier, for modulated and unmodulated carriers; limiting cases of large noise or signal voltages are also discussed. (c) The case of a modulated signal and narrow-band noise, with a determination of the various probability densities associated with the envelope of the wave. (d) The correlation function and mean power associated with the envelope of signal and noise. The low-frequency output of the half-wave μ th-law device is considered. (e) The μ th-law, half-wave rectification of noise alone. This is relevant to the measurement of noise and to the detection of pulse signals in the presence of noise. (f) A general "small-signal" theory in which the peak values of the incoming wave, whether noise or signal plus noise, are so small that overloading and cutoff do not occur.

621.396.822 3239

Thermal Noise in Resistors—S. Rodda: D. A. Bell. Correction to 2072 of July. The paper by Bell there mentioned should have been 2780 of 1938. See also 1914 of 1939 (Moullin).

621.396.822:523.72+523.16 3240

Radio Noise of Extra-Terrestrial Origin and its Effect on Telecommunication Technique—Lehmann. (*See* 3102.)

STATIONS AND COMMUNICATION SYSTEMS

534.861.1:621.316.345:621.396.664 3241

Modern Design Features of CBS Studio Audio Facilities—R. B. Monroe and C. A. Palmquist. (Proc. I.R.E., vol. 36, pp. 778–786; June, 1948). Description of a small, space-saving, single-unit console which is easily accessible for maintenance. See also 2316 of 1946 (Chinn).

534.861.1:621.396.712.3 3242

Speech-Input Equipment for New Oslo Broadcasting House—Julsrud and Weider. (*See* 3008).

621.39 3243

Telecommunication Services for the Fifth Olympic Winter Sports at St. Moritz, from 30th January to 8th February 1948—A. Wettstein. (*Tech. Mitt. Schweiz. Telegr.-Teleph-Verw.*, vol. 26, pp. 99–115; June 1, 1948. In German and French.) Details of the general arrangements, with particular reference to telephone facilities.

621.391.63:534.321.9 3244

Distortion in Light Modulation by an Ultrasonic Cell—Sette. (*See* 3000.)

621.394.441 3245

A Multi-Channel Carrier Telegraph System—A. L. Matte. (*Bell Sys. Tech. Publ. Monogr.* B-1529 4 pp; *Railway Signaling*, vol. 40, pp. 778–781; December, 1947.) Description of the 4OAC1 voice-frequency system, which is specifically designed to meet railway requirements and will provide 12 duplex or simplex telegraphy channels on a 4-wire circuit, or 6 on a 2-wire circuit.

621.396.41 3246

Theoretical Analysis of Various Systems of Multiplex Transmission—V. D. Landon. (*RCA Rev.*, vol. 9, pp. 287–351; June, 1948.) A systematic method of classifying and specifying such systems is discussed. Definitions of 77 associated terms are included. The basic types of frequency division, time division, and triple modulation systems are considered in detail. Formulas for the signal-to-noise ratio for each system relative to that for single-channel AM are obtained and tabulated; due allowance is made for pre-emphasis. More detailed discussion of the relative merits of the systems will be given later.

621.396.41.029.64 3247

A Duplex System of Communications for Microwaves—R. V. Pound. (Proc. I.R.E., vol. 36, pp. 840–844; July, 1948.) A single oscillator is used both as transmitter and as beating oscillator of a superheterodyne receiver. The oscillator frequency is stabilized at the frequency of a high-Q cavity; FM takes place about this stabilization frequency. Duplex communication can easily be arranged by this method and an experimental set is described; the operator initiating communication can ascertain that his signals are being received. The application of the system to ground/aircraft communication and to a booster system for a relay link is discussed. See also 1690 of 1947 and 1311 of June.

621.396.61/.62].029.63 3248

Practical Experiments on 2350 Megacycles—N. T. J. Bevan and L. Grimshaw. (*RSGB Bull.*, vol. 24, pp. 2–4; July, 1948.) Construction and brief performance details of the transceivers used. An oscillator consisting of a type CV90 tube with the modified cavity of a Sutton tube forms the basis of the transmitter. Provision is made for radio-telephone or mcw operation. The associated receiver is superregenerative.

621.396.619.16(083.72) 3249

Standardization of Nomenclature for Pulse Modulation—H. H. Heeroma. (Proc. I.R.E. vol. 36, p. 880; July, 1948.) Statement of terms proposed by the Netherlands Electrotechnical Committee, for use internationally. Terms favored are: pulse-rate, pulse-width, pulse-position, pulse-height, pulse-slope, and pulse-code modulation. Terms deprecated are pulse-frequency, pulse-length, pulse-phase, pulse-displacement, pulse-time, pulse-delay, and pulse-amplitude modulation.

621.396.65.029.63 3250

S-T [studio-transmitter] Link on 920 to 980 Mc/s—R. H. DeWitt. (*FM and Telev.*, vol. 8, pp. 22–25; May, 1948.) A radio link for use where wire lines are either lacking or uneconomic. Block diagrams, numerous illustrations, and a short description of the equipment are given, with performance details. Corner-reflector antennas are used for line-of-sight distances up to 12 miles. Paraboloids are necessary for greater distances up to the maximum of 35 miles.

621.396.933 3251

V.H.F. for Civil Aircraft—(*Wireless World*, vol. 54, pp. 242–243; July, 1948.) The aircraft set weighs only 12 lb, takes 3.75 amp from a 12-v battery and delivers about 300 mw to the antenna. It comprises two crystal multiplier chains, two rf and frequency-changer chains, a common if amplifier with detector, agc and af stages, and a modulator chain. For airport control, a 5-w rack-mounted installation is provided, comprising two separate transmitters and receivers and their power supplies. All four are crystal-controlled and have provision for remote or local operation. The receiver used for direction-finding is very similar to the communication receiver. Two-way communication has been maintained at ranges up to 33 miles with the aircraft at 2000 feet and up to 70 miles with the aircraft at 10,000 feet.

SUBSIDIARY APPARATUS

621-526:621.396 3252

Servomechanisms in Connection with Radio Problems: Part 1—G. Lehmann. (*Onde Élec.*, vol. 28, pp. 213–217; June, 1948.) A general discussion of a wide variety of applications in radio technique.

621.314.634 3253

Small Selenium Rectifiers—J. J. A. Ploos van Amstel. (*Philips Tech. Rev.*, vol. 9, no. 9, pp. 267–276; 1947 and 1948.) Discussion of: (a) the general properties of Se rectifiers, (b) the construction and measurement of the dynamic characteristics of three types, (c) some applications.

621.316.722 3254

Voltage Regulators of the Shunt Type—W. G. Hoyle. (*Rev. Sci. Instr.*, vol. 19, pp. 244–246; vol. 19, April, 1948.) A general equation is derived, giving the relation between the nominal required input voltage and the maximum shunt regulating current for any variation of the input voltage and for any load. The necessary relation between the shunt regulating current and the output current for maximum electrical efficiency is obtained. For a fixed load, the maximum average efficiency of any shunt regulator is $1—k^{1/2})^2$, where k is the maximum variation, per unit, of the supply voltage.

621.316.722 3255

The Effect of Frequency Variations on the Operation of Ferro-Resonant Voltage Stabilizers—B. V. Belyaev. (*Avtomatika i Telemekhanika*, vol. 9, pp. 59–73; January and February, 1948. In Russian.) The effects of various parameters of stabilizers, such as the inductance value, the capacitance of capacitors and the compensating coil, the value and type of the load resistance, etc., on the output voltage variation with frequency are investigated by a graphical/analytical method. The main conclusions are confirmed by experimental results.

621.316.722.1 3256

Electromagnetic Voltage Stabilizers for Valve Apparatus—W. Geyger. (*Funk und Ton*, vol. 2, pp. 308–314; June, 1948.) Discussion of basic principles, with description, characteristics, and performance of some modern types.

621.316.722.1 3257

An Inductively Coupled Series Tube D.C. High Voltage Regulator—R. Pepinsky and P. Jarmotz. (*Rev. Sci. Instr.*, vol. 19, pp. 247–254; April, 1948.) A stabilizer operating in the range 5 to 50kv for currents up to 50 ma. The series regulator tube, which is at high voltage, is coupled inductively to the feedback amplifier at earth potential. The signal from the amplifier provides AM for a rf oscillator, whose output voltage is fed to a transformer, rectified, filtered, and then applied as a dc correcting signal to the grid of the series tube. Insulation between high-voltage and low-voltage circuits is provided in the rf transformer.

621.319.339 3258

Van de Graaff Electrostatic Generator—J. M. Ferguson, E. W. Webster, and T. E. Calverley. (*Elec. Times*, vol. 113, pp. 575–579; May 13, 1948.) A short, illustrated description.

TELEVISION AND PHOTOTELEGRAPHY

621.397.331:513.3 3259

The Application of Projective Geometry to the Theory of Color Mixture—F. J. Bingley. (Proc. I.R.E., vol. 36, pp. 709–723; June, 1948.) IRE 1948 National Convention paper; summary noted in 2647 of October.

621.397.335 3260
Phasing of Remote TV Signals—R. C. Palmer. (*Communications*, vol. 28, pp. 14–16; April, 1948.) An instrument designed to provide phase synchronization between the vertical synchronization intervals of a remote composite picture signal and the studio synchronizing generator.

621.397.5 3261
Electro-Optical Characteristics of Television Systems: Part 2—Electro-Optical Specifications for Television Systems—O. H. Schade. (*RCA Rev.*, vol. 9, pp. 245–286; June 1948.) Part 1, 2940 of November.

621.397.5:535.88:679.5 3262
Plastic Lenses in Television Projection—Starkie. (*See* 3154.)

621.397.5:778.53 3263
Motion Picture Photography of Television Images—R. M. Fraser. (*RCA Rev.*, vol. 9, pp. 202–217; June, 1948.) A description of the apparatus and methods developed for photographing television cathode-ray tube images. 16-mm film is used because 35-mm film costs more and is subject to rigorous fire regulations.

A ZnS blue-fluorescing screen is desirable for photographic recording. In the experimental equipment considered, a 5-inch tube with a flat screen and aluminized blue phosphor was used. A rf high-voltage supply delivered 29 kv to the second anode of the cathode-ray tube, which was mounted at one end of a lathe bed, with the camera at the other. A 2-inch Eastman Anastigmat F 1.6 lens, with apertures from F 2.0 to F 2.8, was used.

The recordings can be retransmitted satisfactorily.

621.397.6:621.398:629.135 3264
Television Equipment for Aircraft—(*Télév. Franç.*, pp. 8–9; May, 1948.) A short account of the complete equipment for the Roc guided projectile, using the mimo pickup tube, and of the "ring" equipment fitted in United States reconnaissance aircraft. See also 2959 to 2962 of 1947.

621.397.61 (083.74) 3265
RMA Standards—(Proc. I.R.E., vol. 36, pp. 932–938; July, 1948.) Electrical performance standards, definitions, and recommended methods of measurement for television broadcast transmitters at frequencies between 44 and 216 Mc.

621.397.62 3266
Television Receiver with Screen Projection (Philips' Receivers).—(*Radio Franç.*, pp. 42–48; May, 1948.) A general description, with details of the folded Schmidt optical system and of certain special features. The picutre size is 31 cm×41 cm.

621.397.62 3267
"Surplus" Television Receiver—L. J. Dalby. (*Wireless World*, vol. 54, pp. 251–252; July, 1948.) Brief description and circuit details of a simple and cheap television receiver which gives good results. The cathode-ray tube is readily obtainable from war surplus equipment.

621.397.8 3268
Cause and Cure of Spurious TV Receiver Oscillations—R. T. Cavanaugh. (*Tele-Tech*, vol. 7, part 1, pp. 36–37, 79; May, 1948.) Causes of spurious oscillations in pentode output stages of line scanning generators are investigated. The use of a magnet to modify the electron paths within the tube is advocated as a cure.

621.397.812.029.62/.63 3269
Comparative Propagation Measurements; Television Transmitters at 67.25, 288, 510, and 910 megacycles—Brown, Epstein, and Peterson. (*See* 3224.)

TRANSMISSION

621.396.61 3270
Transmitters in Parallel—V. O. Stokes. (*Marconi Rev.*, vol. 11, pp. 39–44; April to June, 1948.) The use of transmitters in parallel and the attendant problems are discussed. Methods of phase adjustment and monitoring are described and details given of a completely automatic system of synchronization. Although the case of two transmitters is discussed, there appears to be no technical objection to the use of more than two in parallel.

621.396.61 3271
A New Approach to Single Sideband—D. E. Norgaard. (*QST*, vol. 32, pp. 36–42; June, 1948.) Discussion of practical methods of generating a single-sideband suppressed-carrier signal without the need for sharp filtering and multiple heterodyning. One of the sidebands is removed by a process in which two audio channels with a constant phase difference of 90° are balanced. See also 1805 of July (Nichols).

621.396.61:621.316.729 3272
Synchronization of Low-Power Transmitters—Chamagne and G. Guyot. (*Télév. Franç.*, Supplement *Électronique*, pp. 12–16; May, 1948.) Details of a system suitable for a network of low-power transmitters serving a limited area, such as a large town and its suburbs. A single pilot frequency of 106.6 kc is used; multipliers convert this to the transmission frequency of 960 kc. The quality of the low-frequency modulation could be improved by using FM instead of AM, but the quality with AM is quite satisfactory for the transmission of news, dance music, etc.

VACUUM TUBES AND THERMIONICS

621.385.029.63/.64+538.56+621.384.6 3273
Waves and Electrons Traveling Together—A Comparison between Traveling Wave Tubes and Linear Accelerators—Brillouin. (*See* 3093.)

621.385.029.63/.64 3274
Small-Signal Analysis of Traveling-Wave Tube—C. Shulman and M. S. Heagy. (*RCA Rev.*, vol. 9, p. 366; June, 1948.) Corrections to 2103 of August.

621.385.1:621.365 3275
Tube Trends in Field of Industrial Heating—H. D. Doolittle and E. B. Steinberg. (*Electronic Ind.*, vol. 2, pp. 4–7; May, 1948.) Industrial operating requirements impose severe conditions on heater tubes. Improvements in tube construction technique are described which give increased life and reliability under such exacting conditions.

621.385.38:621.317.761 3276
Study of the Discharge of a Capacitor through a Thyratron. Application to the Study of the Operation of a Direct-Reading Valve Frequency Meter—Legros. (*See* 3187.)

621.396.615.142.2 3277
Millimetre Wavelengths—(*Wireless World*, vol. 54, p. 258; July, 1948.) The Clarendon Laboratory has designed a reflex klystron tunable over the wavelength range 8 to 9 mm. The volume of the klystron cavity is altered by means of a cam mechanism. With a resonator potential of 2.4 kv and a reflector negative potential of 200 v, 10 to 20 mw of continuous-wave power is obtained.

621.396.622.6:546.28 3278
The Silicon Crystal Detector—(*See* 3059.)

621.385.1 3279
Vacuum Tubes [Book Review]—K. R. Spangenberg. McGraw-Hill, London, 860 pp., 45s. (*Wireless Eng.*, vol. 25, p. 237, July, 1948.) "This important book is designed to give a comprehensive account of vacuum tubes and the physical laws on which their behavior depends. It contains a splendid collection of potential-distribution diagrams, nomograms, and design charts pertaining to electron optics, thermionic receiving tubes and the more recent developments, such as klystrons and magnetron oscillators."

MISCELLANEOUS

016.621.39 3280
Technical Bibliographies—(*Electronics*, vol. 21, p. 128; July, 1948.) A list of unpublished bibliographies compiled by the Special Libraries Association can be obtained from R. H. Hopp, Bettelle Memorial Institute, Columbus, Ohio. Other sources of bibliographical information are the Office of Technical Services United States Department of Commerce, and the Engineering Societies Library, New York, N. Y.

06.051 3281
International Radio Conferences—(*Nature* (London), vol. 161, pp. 695–696; May 1, 1948.) An account of the activities of the Union Radio Scientifique Internationale (URSI) and of the Comité Consultatif International des Radio-Communications (CCIR).

061.3:621.396 3282
Scientific Radio—R. L. Smith-Rose. (*Nature* (London), vol. 161, pp. 793–796; May 22, 1948.) A brief account of the proceedings of the Convention on Scientific Radio organized by the IEE in co-operation with the British National Committee for Scientific Radio. The proceedings were divided into four sessions, corresponding in scope to the four URSI commissions. A preliminary survey was made of the British contribution to be presented at the URSI meeting at Stockholm in July, 1948. Four or five short papers were read at each session, surveying progresses in the past few years in various parts of the field of fundamental radio science.

621.39 3283
High-Frequency, Communications, and Remote Control Engineering—(*Brown Boveri Rev.*, vol. 34, pp. 50–57; January to March, 1947.) Illustrations and a few details of (a) multichannel beam telegraphy and telephony equipment, (b) FM usw radio-telephone equipment for communication with mobile stations, (c) medium- and low-power transmitters for commercial operation, (d) high- and medium-power broadcast transmitters for medium, short, and ultrashort waves, (e) transmitting and special tubes, (f) carrier-current telephony and industrial control equipment.

027 3284
British Sources of Reference and Information [Book Review]—T. Besterman (Ed.). Association of Special Libraries and Information Bureaux, London, 56 pp., 6s. (*Jour. Sci. Instr.*, vol. 25, p. 255; July, 1948.) A description of the organization through which books in Great Britain can be borrowed, whether from inside or outside the country. Brief accounts and select lists of the leading library and book organizations, and a list of indispensable works of reference, are given.

621.396 3285
Radio Data Charts [Book Review]—R. T. Beatty, revised by J. McG. Sowerby. Iliffe and Sons, London, 4th edition, 1947, 93 pp., 7s. 6d. (Proc. I.R.E., vol. 36, p. 637; May, 1948.) A revision of the original collection of abacs published in 1930. "The charts are most useful to a radio receiver designer, but are also commendable for student use since many of the nomograms present a physical picture of what would otherwise be a complex formula difficult to comprehend."

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1925	Vol. 13	April, June, August, October, December
1926	Vol. 14	All 6 issues

1927–1938 Volumes 15–26 Monthly

1927	Vol. 15	May, June, July, October, December
1928	Vol. 16	February to December, inc.
1929	Vol. 17	April, May, June, November
1930	Vol. 18	April to December, inc.
1931	Vol. 19	January to November, inc.
1932	Vol. 20	January, March to December, inc.
1933	Vol. 21	All 12 issues
1934	Vol. 22	All 12 issues
1935	Vol. 23	All 12 issues
1936	Vol. 24	January to March, inc.
1937	Vol. 25	February to December, inc.
1938	Vol. 26	All 12 issues

1939–1947 Volumes 27–35 Monthly

New Format—Large Size

1939	Vol. 27	January to March, inc., May, December
1940	Vol. 28	All 12 issues
1941	Vol. 29	All 12 issues
1942	Vol. 30	January, October to December, inc.
1943	Vol. 31	February to December, inc.
1944	Vol. 32	January, August to December, inc.
1945	Vol. 33	February to March, inc., May, June
1946	Vol. 34	February, May to December, inc.
1947	Vol. 35	January to May, inc., November, December
1948	Vol. 36	January to December, inc.

A Cumulative Index covering the periods 1913–1942 and 1943–1947 are available at the same prices as back issues of PROCEEDINGS.

Proceedings Binders

Sturdy binders of blue Spanish-grain fabricoid with gold lettering, which will serve either as temporary transfers or as permanent holders for the PROCEEDINGS, may be obtained in the large size only (1939 to date) at the following prices: $2.50 for plain; $3.00 for Vol. No. or year, or your name imprinted; $3.50 for Vol. No. and name imprinted. Postage is prepaid in United States or Canada; postage to other countries, 50 cents additional.

Membership Emblems

The IRE emblem is available to members in three useful forms; the lapel button, the pin, and the watch charm. Each is of 14-karat gold, enameled in color to designate the grade of membership.

Grade	Background Color
Fellow	Gold
Senior Member	Dark Blue
Member	Light Blue
Associate	Maroon
Student	Green

The lapel button has a screw back with jaws which grip the cloth of the coat. These are priced at $3.00 each. The pin, at $3.50 each, is provided with a safety catch. The watch charm, enameled on both sides and equipped with a suspension ring for attaching to a watch charm or fob, is $5.50.

Prices on emblems are the same for all grades of membership and include Federal tax, postage, and insurance or registered-mail fee.

Remittance should accompany your order.

Please do not send cash except by registered mail.

THE INSTITUTE OF RADIO ENGINEERS, INC.
1 East 79 Street, New York 21, New York

Current IRE Standards

In addition to the material published in the PROCEEDINGS OF THE I.R.E., Standards on various subjects have been printed. These are available at the prices listed below.

		Price
1)	**Standards on Electroacoustics, 1938 Definitions of Terms, Letter and Graphical Symbols, Methods of Testing Loud Speakers.** (vi + 37 pages, 6 x 9 inches)	$0.50
2a)	**Standards on Electronics: Definitions of Terms, Symbols, 1938.** A Reprint (1943) of the like-named section of "Standards on Electronics, 1938." (viii + 8 pages, 8½ x 11 inches)	$0.20
2b)	**Standards on Electronics: Methods of Testing Vacuum Tubes, 1938.** A Reprint (1943) of the like-named section of "Standards on Electronics, 1938." (viii + 8 pages, 8½ x 11 inches)	$0.50
3a)	**Standards on Transmitters and Antennas: Definitions of Terms, 1938.** A Reprint (1942) of the like-named section of "Standards on Transmitters and Antennas, 1938." (vi + 10 pages, 8½ x 11 inches)	$0.20
3b)	**Standards on Transmitters and Antennas: Methods of Testing, 1938.** A Reprint (1942) of the like-named section of "Standards on Transmitters and Antennas, 1938." (vi + 10 pages, 8½ x 11 inches)	$0.50
4a)	**Standards on Radio Receivers: Definitions of Terms, 1938.** A Reprint (1942) of the like-named section of "Standards on Radio Receivers, 1938." (vi + 6 pages, 8½ x 11 inches)	$0.20
.b)	**Standards on Radio Receivers: Methods of Testing Broadcast Radio Receivers, 1938.** A Reprint (1942) of the like-named section of "Standards on Radio Receivers, 1938." (vi + 20 pages, 8½ x 11 inches)	$0.50
4c)	**Standards on Radio Receivers: Methods of Testing Frequency-Modulation Broadcast Receivers, 1947.** (vi + 15 pages, 8½ x 11 inches)	$0.50
5a)	**Standards on Radio Wave Propagation: Definitions of Terms, 1942.** (vi + 8 pages, 8½ x 11 inches)	$0.20
5b)	**Standards on Radio Wave Propagation: Measuring Methods, 1942.** Methods of Measuring Radio Field Intensity, Methods of Measuring Power Radiated from an Antenna, Methods of Measuring Noise Field Intensity. (vi + 16 pages, 8½ x 11 inches)	$0.50
5c)	**Standards on Radio Wave Propagation: Definitions of Terms Relating to Guided Waves, 1945.** (iv + 4 pages, 8½ x 11 inches)	$0.20
6a)	**Standards on Facsimile: Definitions of Terms: 1942.** (vi + 6 pages, 8½ x 11 inches)	$0.20
6b)	**Standards on Facsimile: Temporary Test Standards, 1943.** (iv + 8 pages, 8½ x 11 inches)	$0.20
7)	**Standards on Piezoelectric Crystals: Recommended Terminology, 1945.** (iv + 4 pages, 8½ x 11 inches)	$0.20
8a)	**Standards on Television: Methods of Testing Television Transmitters, 1947.** (vi + 18 pages, 8½ x 11 inches)	$0.75
8b)	**Standards on Television: Methods of Testing Television Receivers, 1948.** (vi + 32 pages, 8½ x 11 inches)	$1.00
8c)	**Standards on Television: Definitions of Terms, 1948.** (iv + 4 pages, 8½ × 11 inches)	$0.50
9)	**Standards on Antennas, Modulation Systems, and Transmitters: Definitions of Terms, 1948.** (vi + 25 pages, 8½ x 11 inches)	$0.75
10)	**Standards on Abbreviations, Graphical Symbols, Letter Symbols, and Mathematical Signs, 1948.** (vi + 21 pages, 8½ x 11 inches)	$0.75
11)	**Standards on Antennas: Methods of Testing, 1948** (vi + 18 pages, 8½ × 11 inches)	$0.75
	Normas Sobre Receptors de Radio, 1938.* A Spanish-language translation of "Standards on Radio Receivers, 1938," by the Buenos Aires Section of The Institute of Radio Engineers. (vii + 64 pages, 6 x 9 inches)	Two Argentine Pesos (Postpaid)

** Not carried in stock at IRE Headquarters in New York. Obtainable only from Señor Domingo Arbó, Editor of Revista Telegrafica, Peru, 165, Buenos Aires, Argentina.*

ASA STANDARDS

(Sponsored by the IRE)

ASA1)	**American Standard: Standard Vacuum-Tube Base and Socket Dimensions.** (ASA C16.2-1939.) (8 pages, 7¾ x 10⅝ inches)	$0.20
ASA2)	**American Standard: Manufacturing Standards Applying to Broadcast Receivers.** (ASA C16.3-1939.) (16 pages, 7¾ x 10⅝ inches)	$0.20
ASA3)	**American Standard: Loudspeaker Testing.** (ASA C16.4-1942.) (12 pages, 7¾ x 10⅝ inches)	$0.25
ASA4)	**American Standard: Volume Measurements of Electrical Speech and Program Waves.** (ASA C16.5-1942.) (8 pages, 7¾ x 10⅝ inches)	$0.20

PRICES ARE NET AND INCLUDE POSTAGE TO ANY COUNTRY.
INCLUDE REMITTANCE WITH ORDER AND ADDRESS.

THE INSTITUTE OF RADIO ENGINEERS, INC.
1 East 79 Street, New York 21, N. Y.

new klystron tubes

NOW AVAILABLE FOR MICROWAVE RELAYS

■ Four Sperry Reflex Klystron oscillators for microwave relay systems are now available for commercial use. These Klystrons can be used either as transmitting types or local oscillators. They can also be used in the laboratory as bench oscillators in the development of microwave relay systems.

■ With these new Klystron tubes, relay techniques are simplified and the mechanical problems associated with lower frequency relay links are overcome.

■ Other Sperry Klystrons are available in the frequency range from 500 to 12,000 megacycles. Our Industrial Department will gladly supply further information.

SPERRY

Sperry Gyroscope Company, Inc.

EXECUTIVE OFFICES: GREAT NECK, NEW YORK • DIVISION OF THE SPERRY CORPORATION

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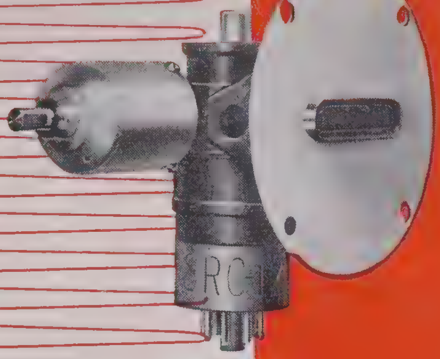
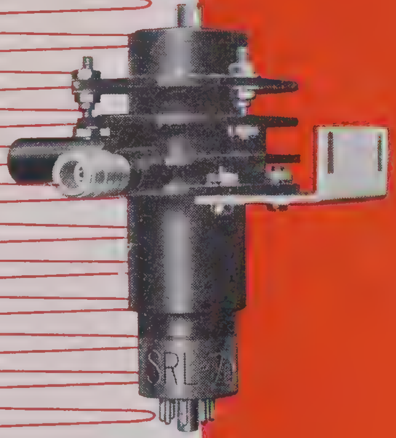
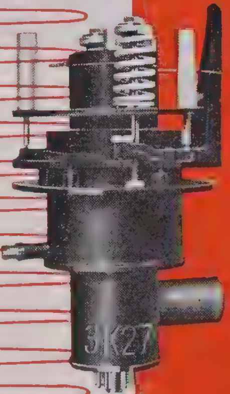


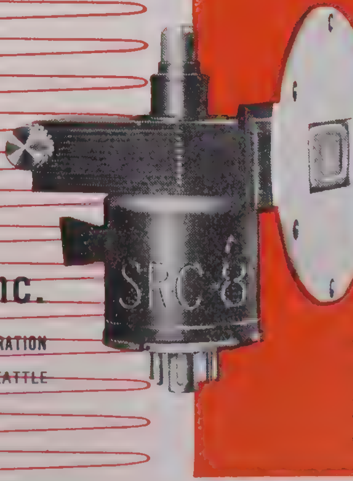
TYPE SRC-12, 20, 21
FREQUENCY 4400-5000 mc
POWER OUTPUT 5 WATTS MAX.



TYPE SRL-7a
FREQUENCY 1825-2100 mc
POWER OUTPUT .5 WATTS MAX.



TYPE 3K27
FREQUENCY 750-960 mc
POWER OUTPUT 1.5 WATTS MAX.



TYPE SRC-8 SERIES
FREQUENCY 5500-7800 mc*
POWER OUTPUT 4.5 WATTS MAX.

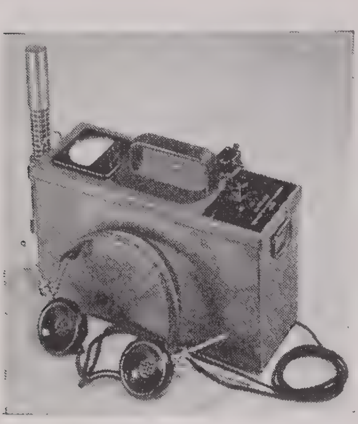
*The SRC-8 tubes are available in 100 megacycle steps except for 3 models, SRC-8A, SRC-8B, SRC-8C which are bench oscillators in 400 megacycle steps from 5850 to 7050

NEWS and NEW PRODUCTS

January, 1948

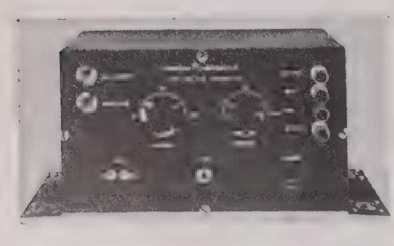
Portable Radioactivity Meter

Intended for qualitative and semi-quantitative measurement of X, gamma, and beta radiation, a new-model portable meter has been announced by **Instrument Development Laboratories.**, 223–233 W. Erie St., Chicago 10, Ill.



The Model 2610 Meter has three ranges: 0.2, 2, and 20 milliroentgens per hour full scale. These give the instrument a range below the cosmic-ray background and above the health tolerance level. The electronic count-rate circuit uses two hearing-aid-type tubes and is completely battery-operated. A visual reading of the amount of radiation present is given by a meter, and earphones are provided for an aural indication. An adjustable shield can be set to prevent the detection of beta particles, so that the user can distinguish between beta and other radiation.

Mobile Transmitter



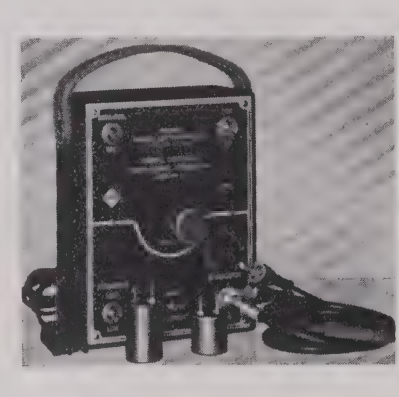
Recently announced by **Eastern Amplifier Corp.**, 794 East 140th St., New York 54, N. Y., the Model 600 is a complete self-powered 27–30-Mc. mobile transmitter, designed for portable and mobile use.

This instrument measures only 10½×6×6½ inches including the built-in power supply. It has automatic antenna changeover from receiver to transmitter. The output will load any type antenna from 10 ohms to several thousand ohms. Model 600 uses four tubes, 1 2E30 crystal oscillator and doubler, 1 2E30 power amplifier, 1 2E30 plate modulator, and an OZ4 rectifier.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

New Signal Generator

Crystal-controlled precision is combined with portability in the new Model 117 Mini-Signal Generator developed by **Premier Crystal Laboratories, Inc.**, 57–67 Park Row, New York 7, N. Y. According to the manufacturer, with this new device and the appropriate crystal, any frequency from 100 kc. to 10.8 Mc., with harmonic operation for higher frequencies, can be obtained using any 110-volt power supply, a.c. or d.c.



Mounted in a rugged cast-aluminum case, this instrument is suitable for roving inspection in assembly departments and for field checking of communications equipment. It produces an r.f. signal modulated by an audio frequency of approximately 400 cycles, under the control of a continuously variable attenuator and an off-on switch. The generator draws 17 watts, weighs 3½ pounds, measures 3×5×7 inches, and comes equipped with a 6-foot cord and 53-inch leads with insulated clips.

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Mrs. Harriet P. Watkins, Industry Research Division, Proceedings of the I.R.E., Room 707, 303 West 42nd St., New York 18, N.Y.** Photographs, and electrotypes if not over 2″ wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

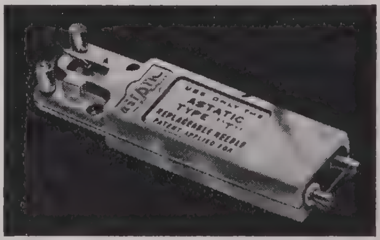
Space-Saving Motor Capacitors

AEROVOX
TYPE
MFD.-330VAC

This compact unit is one of a new line of bracket-mounted, armored motor-starting capacitors, (Series SRVC) recently announced by **Aerovox Corp.**, New Bedford, Mass.

These new capacitors are claimed to be fully protected against mechanical damage, dirt, and the usual climatic hazards. The steel casing measures only 2$\frac{1}{16}$ inches in diameter by 2⅞ to 3¾ inches long, depending upon voltage and capacitance ratings. Standard ratings are 110, 220, 330, 440, and 660 volts a.c., while capacitances range from 1 to µfd. The flexible pigtail leads from the encased capacitor are brought out through the insulated hole in the cap.

Crystal Phono Cartridge

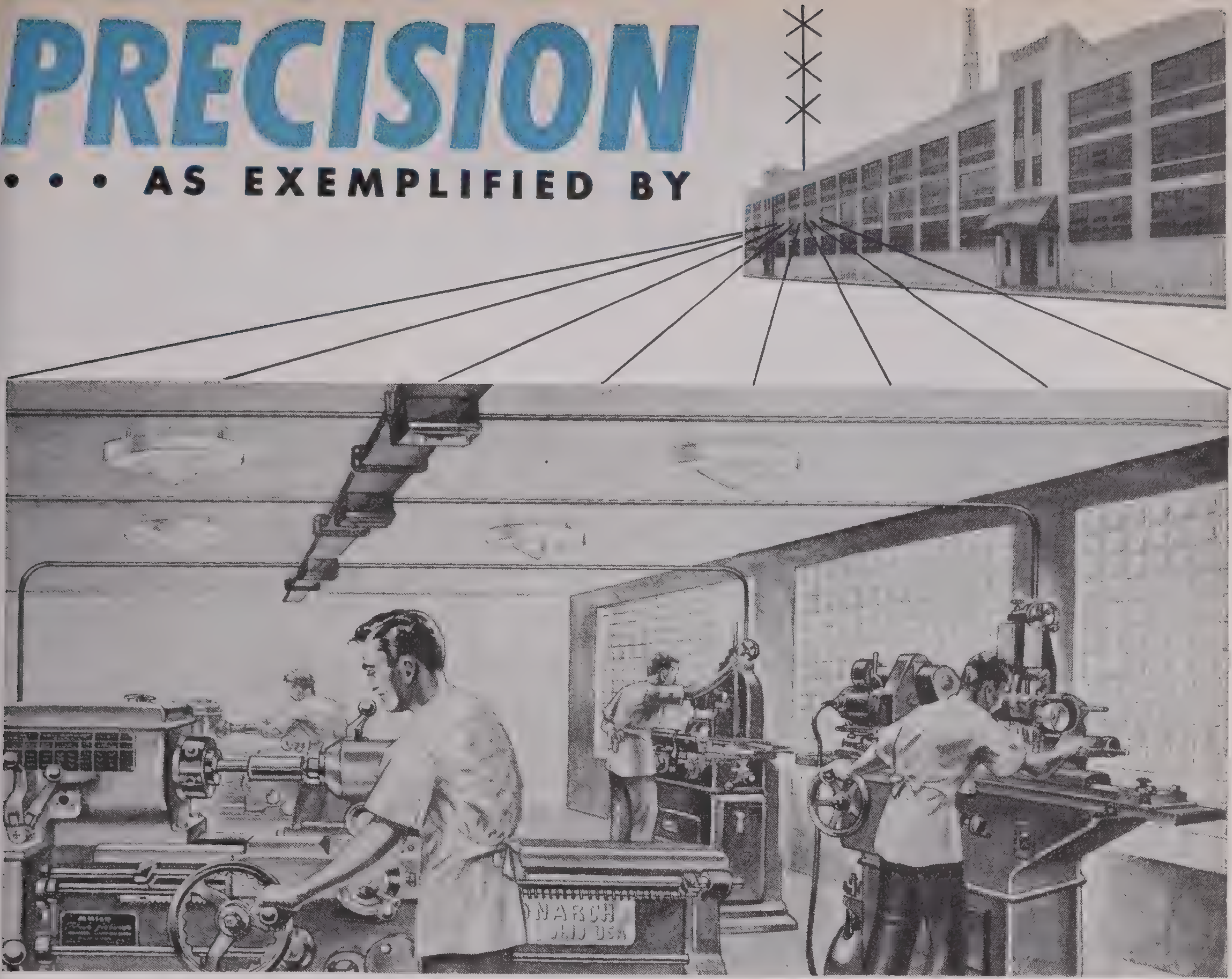


The Astatic Corp., of Conneaut, Ohio, has introduced a new, low needle-talk reproducer in the low-priced field, designated as type "LT" Crystal Phono Cartridge.

Output voltage, 1.00 volt average at 1000 c.p.s.; minimum needle pressure, ¾ ounce; cutoff frequency 4000 c.p.s.; and replaceable Type "T" needle with "Electro Formed" precious-metal playing tip. The manufacturer reports that, in the reproduction of high frequencies, the "LT" cartridge is noticeably free from disagreeable surface noise or needle talk for greater clarity and beauty of tone reproduction.

PRECISION

• • • AS EXEMPLIFIED BY



SHERRON'S ELECTRO-MECHANICAL LABORATORY

Mechanical accuracy is indispensable in modern electronics design. Our concept of its importance — in terms of precision control and fool-proof operation of electronics devices—is demonstrated in our addition of the Sherron precision electro-mechanical laboratory.

Humidity-temperature-and-dust-controlled, the Sherron electro-mechanical laboratory is fully geared to solve electro-mechanical manufacturing problems on a model or prototype basis for electronics manufacturers.

The most modern precision machines and tools make up the apparatus of this laboratory . . . lathes, shapers, jig bores, heat treating equipment, locators, millers. Plus a full complement of standards, gauges, mechanical measuring instruments.

Combined with Sherron's electronics research and development laboratory, sheet metal fabrication facilities, this modern precision electro-mechanical laboratory climaxes the all-inclusive electronics service Sherron offers to electronics manufacturers.

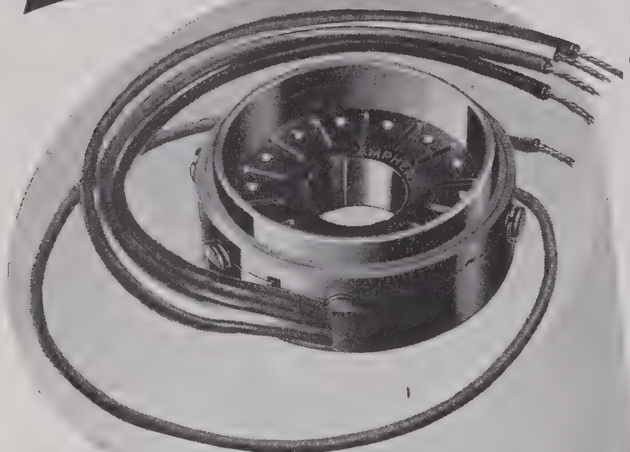
Among the many electro-mechanical projects this department is geared for are: (1) Special Development Precision Wave Guides; (2) Computers; (3) Mechanical Equipment for Electronoptics; (4) Vacuum Tube Structures; (5) Precision Tuning Units; (6) Precision Drive Mechanisms; (7) Servo Mechanisms.

SHERRON ELECTRONICS CO.

Division of Sherron Metallic Corporation

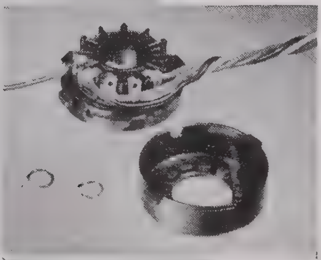
1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK

QUALITY SHORT CUT TO MASS PRODUCTION OF TV RECEIVERS...



COMPACT, CUSTOM-WIRED

DUODECAL AND DIHEPTAL



AMPHENOL

CATHODE RAY TUBE SOCKET ASSEMBLIES

- Amphenol custom-wired cathode ray tube socket assemblies are unusually compact. Leads are grouped within the housing in unit cable form and brought through the side of the socket in any of six positions. This effects a further saving of space. High voltage lead may be segregated from main trunk wires. Safety socket cap enclosing all wiring connections is easy to remove. Recessed socket front shields operator or serviceman from high voltages; serves also as a guide for tube insertion. Creepage barriers between contacts provide long leakage paths and positive lead wire separation. *For manufacturer's applications, sockets are furnished in wired assemblies.*

Duodecal Tube Sockets: For most popular television viewing tubes with a maximum of twelve pins on a pin circle diameter of 1.063 inches.

Diheptal Tube Sockets: Made in two sizes, for small (2.050 inch) diameter tube bases, also for medium (2.250 inch) diameter bases. Both provide for a maximum of fourteen pins on a 1.750 inch diameter pin circle.

Complete technical data, and prices, are available.
Write for them today!

AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE • CHICAGO 50, ILLINOIS

COAXIAL CABLES AND CONNECTORS—INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT—ANTENNAS—RADIO COMPONENTS—PLASTICS FOR ELECTRONICS

SECTION MEETINGS

ATLANTA

"New Instruments for F.M. Broadcasting and Microwave Applications," by I. G. Easton, General Radio Company; October 24, 1947.

BALTIMORE

"Power Line Carrier," by M. H. Wood, Westinghouse Electric Corporation; November 18, 1947.

BOSTON

"Microwave Filters Using Quarter-Wave Couplings," by R. M. Fano, Massachusetts Institute of Technology; November 13, 1947.

BUFFALO-NIAGARA

"Radar as an Aid to Aviation and Marine Navigation," by R. C. Jensen, General Electric Company; November 20, 1947.

CEDAR RAPIDS

"Applications of Radio in the Common Carrier Communication Field," by D. B. Harris, Northwestern Bell Telephone Company; October 15, 1947.

"A New Wide-Band Modulation System for A.M. Broadcasting," by R. J. Rockwell, Crosley Broadcasting Company; November 19, 1947.

CINCINNATI

"Beam Deflection Mixer Tubes," by E. W. Herold, Radio Corporation of America Laboratories; November 18, 1947.

COLUMBUS

"Circular Polarization for F.M. and Effect of Feed on Pattern of Wire Antennas," by C. E. Smith, United Broadcasting Company; and R. A. Fouty and D. C. Cleckner, Ohio State University Research Foundation; October 10, 1947.

CONNECTICUT VALLEY

"Servomechanisms in Application," by J. L. Bower, Yale University; November 20, 1947.

DALLAS-FORT WORTH

"Theory and Application Notes on the Use of Intermodulation Test Equipment," by J. K. Hilliard, Altec-Lancing Corporation; November 4, 1947.

DAYTON

"Voltage Regulating Devices," by C. H. Humes, Sola Electric Company; November 13, 1947.

DETROIT

"Magnetic Recording," by T. E. Lynch, The Brush Development Company; September 19, 1947.

"The Functions and Organization of the Field Engineering and Monitoring Division of the Federal Communications Commission," by E. H. Lee, Federal Communications Commission; October 17, 1947.

INDIANAPOLIS

"An Electronic Course Computer for Aerial Navigation," by F. J. Gross, Civil Aeronautics Association; September 26, 1947.

"Airborne Magnetometers," by D. E. Brewer, Esterline Angus Company; October 24, 1947.

LONDON (Canada)

"Talk Tracks that Turn," by H. A. Blachford, Public Relations Representative; November 7, 1947.

LOS ANGELES

"The Bell System Plan for Transmission of Television Video Signals," by E. H. Schreiber, Pacific Telephone and Telegraph Company; November 18, 1947.

Election of Officers; November 18, 1947.

(Continued on page 38A)

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

tronic applications. It costs little and mounts in places where a rectifier tube and socket won't fit. Tests prove that this new selenium rectifier will outlast several 117-volt rectifier tubes. Installation is easier too—only two soldering operations and a minimum of mounting hardware are required.

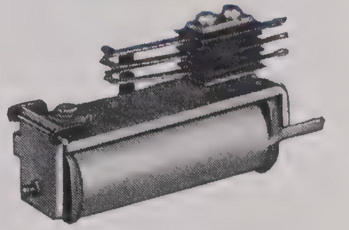
These rectifiers have an exceptionally high inverse-peak rating, and the inverse current is extremely low even with peak voltages up to 350 volts. At rated current output, the forward drop is five volts or less. Ratings are based on ambients of 50 to 60 C. Check Bulletin 21-127 for more information on this and other General Electric radio rectifiers.

NEW MACHINABLE PLASTIC FOR UHF INSULATION

A new arrival in the plastics insulator field is G-E No. 1422, which offers characteristics of advantage in the manufacture of ultra-high-frequency equipment, television, FM, radar, and radio sets, and many other electronic applications. Possessing a dielectric constant of 2.5 to 2.6 with a power factor of .0006 to .0009 at 3000 mc, G-E No. 1422 exhibits unusual heat resistance and excellent machinability.

Indicative of its machinability is the industrial production of r-f connector beads from G-E No. 1422 on automatic and semi-automatic screw machines. As a low-loss dielectric in the hands of the electric-equipment designer, it affords an excellent low-cost means of producing experimental models and small production quantities through the use of standard machine shop tools. Check coupon for technical report.

HANDLES 12 CIRCUITS SIMULTANEOUSLY



This new telephone-type relay is capable of handling as many as 12 circuits in a wide variety of contact combinations. Designed for multipurpose use in industrial electronic apparatus, communications and signaling equipment, these devices have service lives measured in millions of operations. Working from five basic contact arrangements, combinations can be stacked to satisfy intricate circuit switching requirements. Silver, palladium, or tungsten contacts can be supplied; the choice depends on rating and life specifications.

More than 500 different coils are available, with ratings ranging from 1 to 250 volts, and 0.1 to 26,000 ohms. This varied selection of coil ratings makes it possible to match closely the coil voltage and resistance with the rating of the energizing circuits. Check Bulletin GEA-4859 for full details.

TO MEASURE TUBE LIFE

GENERAL ELECTRIC

Now available for immediate delivery, General Electric Type KT time meters are ideal for inclusion in transmitters and other electronic equipment where knowledge of tube "on time" is important. They can record operating time in hours, tenths of hours, or minutes, and are built in four forms: round or square for panel mounting, portable with attached base, or for conduit mounting. Those designed for panel mounting are housed in small Textolite cases that harmonize with other panel devices.

Telechron motor drive assures an accurate record of tube operation over a long period of time. They can also be used on electronic production tools, such as resistance welders, to keep an accurate record of machine operating time. Researchers use them for measuring time intervals, verifying circuit operation, and life testing. Bulletins GEA-3299 and GEA-1574 have full details.

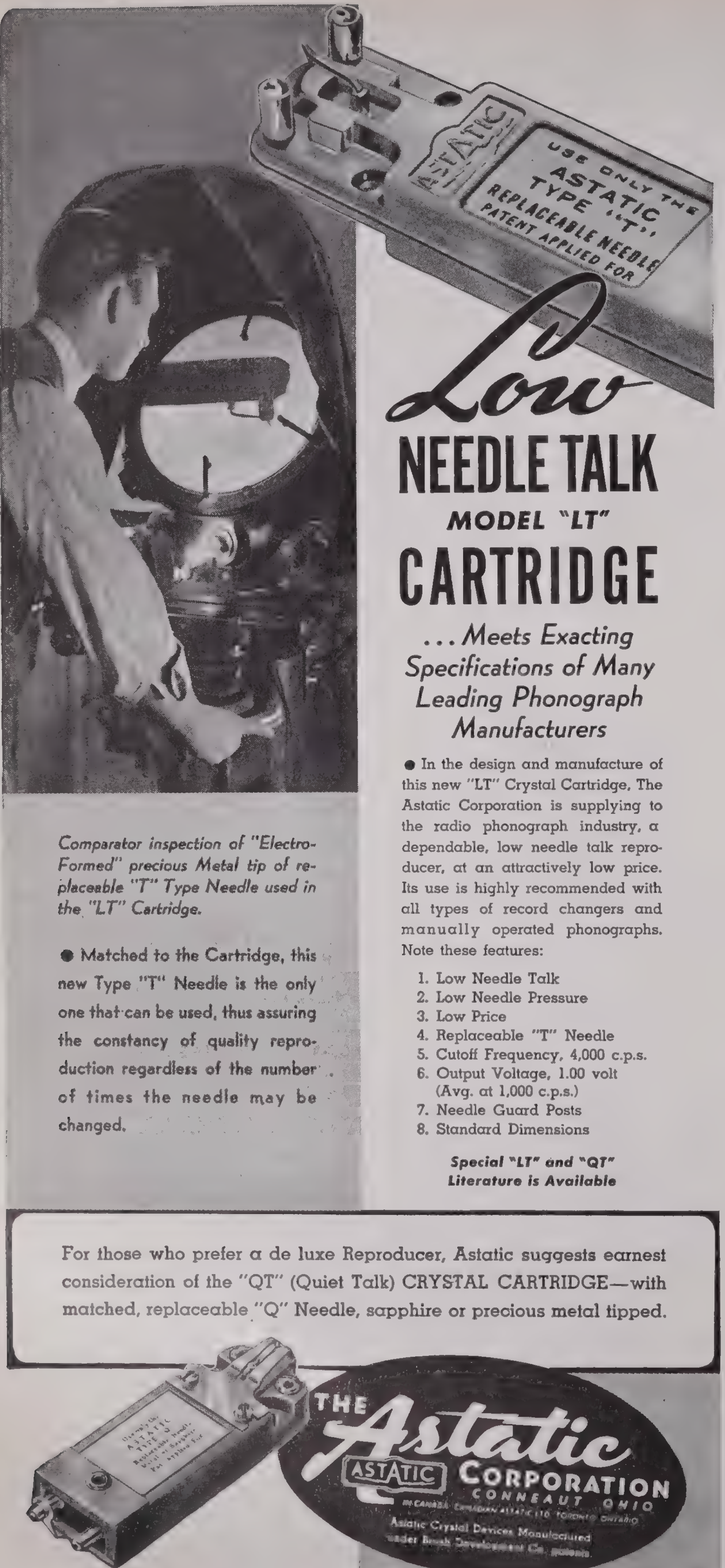
GENERAL ELECTRIC COMPANY, Section C642-16
Apparatus Department, Schenectady 5, N. Y.

Please send me:

☐ GEA-2621 400-v D-c Capacitors
☐ GEA-3299 } Type KT Time Meter
☐ GEA-1574 }
☐ 21-127 Selenium Rectifier
☐ GEA-4859 Telephone-type Relay
☐ Report on G-E No. 1422 Plastic

NOTE: More data available in Sweets' File for Product Designers.

Name..........
Company..........
Address..........
City.......... State..........


USE ONLY THE ASTATIC TYPE "T" REPLACEABLE NEEDLE PATENT APPLIED FOR
ASTATIC
Use only the ASTATIC TYPE Q Replaceable Needle Metal or Sapphire Pat. Applied For

Low
NEEDLE TALK
MODEL "LT"
CARTRIDGE

...Meets Exacting Specifications of Many Leading Phonograph Manufacturers

● In the design and manufacture of this new "LT" Crystal Cartridge, The Astatic Corporation is supplying to the radio phonograph industry, a dependable, low needle talk reproducer, at an attractively low price. Its use is highly recommended with all types of record changers and manually operated phonographs. Note these features:

1. Low Needle Talk
2. Low Needle Pressure
3. Low Price
4. Replaceable "T" Needle
5. Cutoff Frequency, 4,000 c.p.s.
6. Output Voltage, 1.00 volt (Avg. at 1,000 c.p.s.)
7. Needle Guard Posts
8. Standard Dimensions

Special "LT" and "QT" Literature is Available

Comparator inspection of "Electro-Formed" precious Metal tip of replaceable "T" Type Needle used in the "LT" Cartridge.

● Matched to the Cartridge, this new Type "T" Needle is the only one that can be used, thus assuring the constancy of quality reproduction regardless of the number of times the needle may be changed.

For those who prefer a de luxe Reproducer, Astatic suggests earnest consideration of the "QT" (Quiet Talk) CRYSTAL CARTRIDGE—with matched, replaceable "Q" Needle, sapphire or precious metal tipped.

THE Astatic CORPORATION
CONNEAUT OHIO
IN CANADA: CANADIAN ASTATIC LTD. TORONTO, ONTARIO
Astatic Crystal Devices Manufactured under Brush Development Co. patents

SECTION MEETINGS

(Continued from page 34A)

MONTREAL

"Facsimile," by F. A. Hester, Radio Inventions, Inc.; October 29, 1947.

"V.H.F. and Microwave Communications," by J. B. Knox, RCA Victor Company; November 19, 1947.

NEW YORK

"A Computer for Electronic Control of Printing," by J. W. Ludwig, Electronic Control Corporation; October 23, 1947.

"Recent Advances in the Theory of Communication," by A. G. Clavier, Federal Telecommunication Laboratories; B. D. Loughlin, Hazeltine Electronics Corporation; J. R. Pierce, Bell Telephone Laboratories; and C. E. Shannon, Bell Telephone Laboratories; November 12, 1947.

NORTH CAROLINA-VIRGINIA

"Operating Problems and their Solutions," by W. P. Seagraves, Station WPTF; November 21, 1947.

OTTAWA

"Visual and Radar Observations on the Perseid Meteor Shower of August, 1947," by P. M. Millman and D. W. R. McKinley, Dominion Observatory and National Research Council; November 27, 1947.

PHILADELPHIA

"The Teleran Air Navigation and Traffic Control System," by D. H. Ewing, RCA Victor Division; November 6, 1947.

PORTLAND

"An Oscilloscope for the Observance of Various Waveforms up to Frequencies of 10 Mc.," by H. Vollum, Tektronix, Inc.; October 23, 1947.

PRINCETON

"Ferromagnetism—Phenomena and Materials," by R. M. Bozorth, Bell Telephone Laboratories; November 13, 1947.

SACRAMENTO

"Simplified 2-Meter Control," by J. Reinarts, Radio Corporation of America; October 30, 1947.

ST. LOUIS

"Radio-Frequency Heating," by R. H. Schneider, Westinghouse Electric Corporation; November 20, 1947.

SAN DIEGO

"Notes on Standing Wave Measurements on Transmission Lines," by L. E. Swarts, Jr., United States Navy Electronics Laboratory; November 4, 1947.

SAN FRANCISCO

"Radio-Frequency Heating," by R. Bollaert, Westinghouse Corporation; November 5, 1947.

SYRACUSE

"Industrial Atomic Power," by E. H. Bancker, General Electric Company; November 24, 1947.

WASHINGTON

Movie Shorts, courtesy of Westinghouse Electric and Manufacturing Company; November 10, 1947.

WILLIAMSPORT

"The Application of Electronics to Railway Operation," by H. W. Richards, Electronic Railway Signal Company; November 19, 1947.

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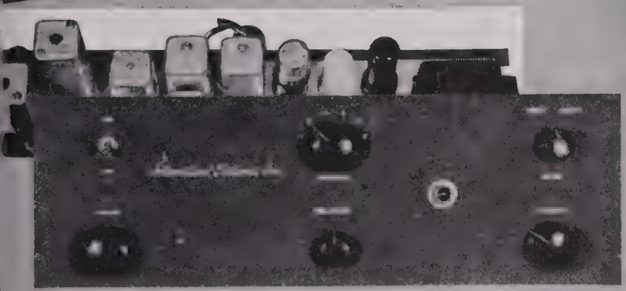

for CW *and* CS

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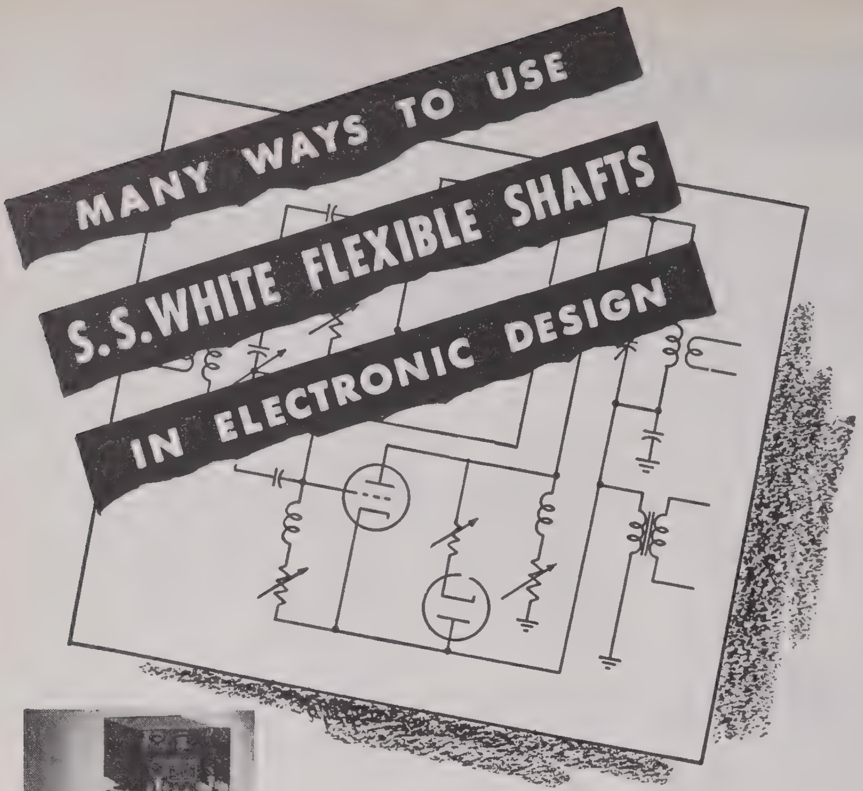

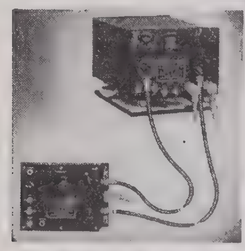

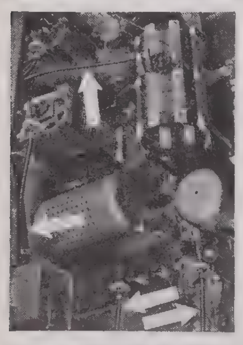

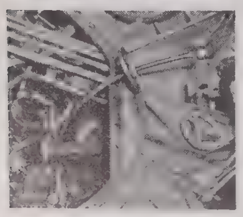

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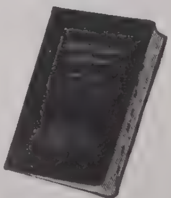

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STUDENT BRANCH MEETINGS

University of Alberta, I.R.E. Branch

"Use of the Seismograph in Oil Explorations," by R. D. Hall and K. Provost, Students; November 19, 1947.

University of California, I.R.E.—A.I.E.E. Branch

"Electronics Applied to Mass Spectography," by W. A. Thurston, Shell Development Company; November 7, 1947.

College of the City of New York, I.R.E. Branch

"Professional Engineers in Training," by Norman Alpert, Instructor; October 28, 1947.

"Stamped Circuits," by Milton Koenigstain, Franklin Manufacturing Company; November 18, 1947.

North Carolina State College, I.R.E. Branch

"Directional Couplers," by C. S. Wright, Student; November 12, 1947.

Rutgers University, I.R.E.—A.I.E.E. Branch

"Resolved—the Engineering Curriculum Should be Lengthened to Five Years," Open Forum; October 22, 1947.

"Laying of Submarine Cables," and "Manufacture of Cables," Moving Pictures of the Okonite Company; November 12, 1947.

Stanford University, I.R.E.—A.I.E.E. Branch

"Some Effects of Electronics on Naval Operations in the Pacific During World War II," by John R. Redman, Rear Admiral, USN; November 5, 1947.

University of Texas, I.R.E.—A.I.E.E. Branch

"The Writing of Reports for Electrical Engineering Laboratories," by Professors W. R. Warner and W. A. Helwig, and Students N. Isaloe and J. Ford; October 15, 1947.

"The Selection of a Site for a Power Plant," by N. B. Gussett, City Public Service of San Antonio; October 21, 1947.

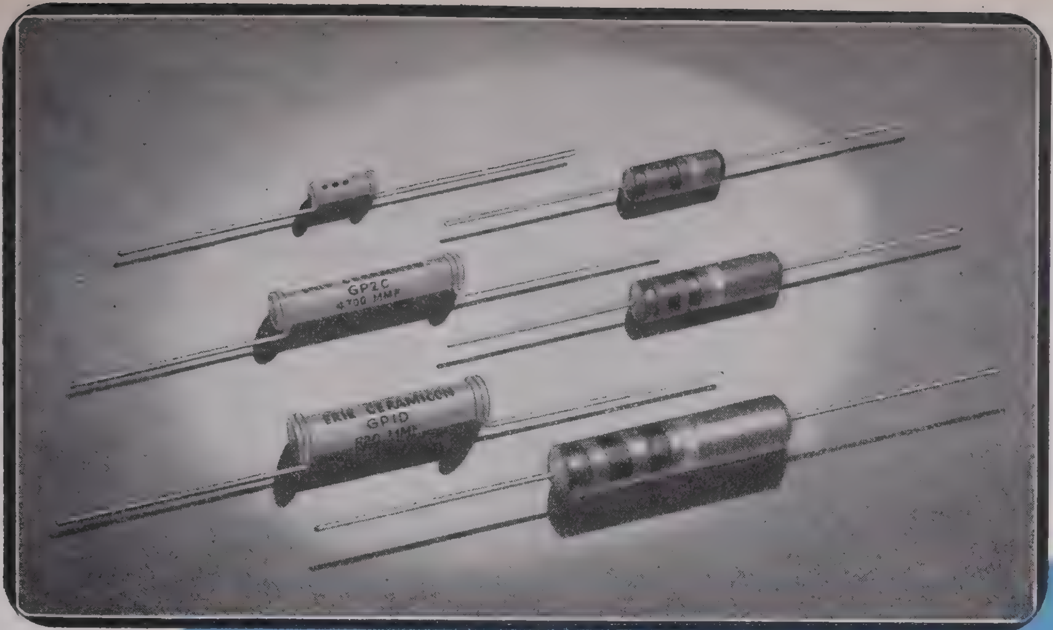
MEMBERSHIP

The following transfers and admissions were approved on December 9, 1947, to be effective as of January 2, 1948:

Transfer to Senior Member

Dike, S. H., 14 D Cedar Dr., Baltimore 20, Md.
Glasford, G. M., 271 Brook Ave., Passaic, N. J.
Hoisington, D. B., 48-02 Browvale Lane, Little Neck, L. I., N. Y.
Kennedy, A., 299 Innes Rd., Wood-Ridge, N. J.
LaPierre, V. M., Panagra, Lima, Peru, South America.
Lehr, P. N., 75-40 Austin St., Forest Hills, N. Y.
Lescarboura, A. C., The Adshop, Croton-on-Hudson, N. Y.
Mahalingam, N., 223 International House, New York 27, N. Y.
Schlegelmilch, R. O., 20 Elizabeth Pkwy., Eatontown, N. J.

(Continued on page 42A)



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Electronics Division

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SECTION MEETINGS

(*Continued from page 40A*)

Stephens, T. C., 1311 B Ave., N.E., Cedar Rapids, Iowa.
White, W. D., Airborne Instruments Laboratory, Mineola, L. I., N. Y.

Admission to Senior Member

Cook, W. A., 48 Misiones, Buenos Aires, Argentina
Fisher, J. F., 1509 W. Tioga St., Philadelphia 40, Pa.
Hirshman, C. L., 6 Bramley Mansions, Bramley Rd., Southgate, London, N. 14, England
Piper, C. A., 85 Van Reypen St., Jersey City 6, N. J.
Weiss, H. G., Box 1663, Los Alamos, N. M.
Wilson, J. E., 1520 San Rae Dr., Dayton 9, Ohio

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Auditore, C. J., 40-71 Elbertson St., Elmhurst, L. I., N. Y.
Beckhardt, T. G., 1906 Ave. R, Brooklyn 29, N. Y.
Bedford, P. L., 9511 Seminole St., Silver Spring, Md.
Bowne, W. L., 21 Foxcroft Rd., Winchester, Mass.
Clark, R. R., 8292 Wisconsin Ave., Detroit 4, Mich.
deOnis, A., Brentwood Transmitting Station, Mackay Radio and Telegraph Co., Brentwood, L. I., N. Y.
Dewitz, G. H., 917 Mill Hill Terr., Southport, Conn.
Fallain, F. D., 1914 Miller Rd., Flint 3, Mich.
Fraser, R., 122 Cutter Mill Rd., Great Neck, L. I., N. Y.
Gulden, E. V., 140 Oak Knoll Dr., Dayton 9, Ohio
Hauser, P. D., 1430 Gascho Dr., Dayton 3, Ohio
Herson, J. L., 1262—21 St., N.W., Washington 6, D. C.
Head, J. W., 18868 Bretton Dr., Detroit 23, Mich.
Hoenig, W., 127 West 82 St., New York 24, N. Y.
Kaye, H. W., 4 Cromwell Place, White Plains, N. Y.
Kellher, J. J., 257 N. Thomas St., Arlington, Va.
Leslie, J. M., 355 King St., W., Toronto, Ont., Canada
Lewis, G. E., 4373 Cleveland, San Diego 3, Calif.
Marsh, H. S., 329 S. Lee St., Alexandria, Va.
Meier, D. J., Watson Laboratories, Red Bank, N. J.
Metcalf, D. E., 1749 Magnolia Ave., Los Angeles 6, Calif.
Pickett, J. H., Aerovox Canada, Ltd., 1551 Barton, E., Hamilton, Ont., Canada
Pratt, R. L., 152 DeSoto St., Pittsburgh 13, Pa.
Rahman, S. M. F., 608 S. Dearborn St., Chicago, Ill.
Rao, M. K., c/o Dr. N. Alahasingari, Maharnipetta P. O., Vizagapatam, S. India
Record, W. V., 2260 Grande Ave., Cedar Rapids, Iowa
Schulz, S. W., 3132 Fourth St., S.E., Minneapolis, Minn.
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Spittle, S. E., 30 John St., Red Bank, N. J.
Spragg, L. A., 14996 Alexander, Detroit 23, Mich.
Swarthe, E., 5118 Harold Way, Los Angeles 27, Calif.
Swarthout, W. M., 13 Teel Street Pl., Arlington 74, Mass.
Tavaniotis, C., Devon Hotel, 70 W. 55 St., New York 19, N. Y.
Von Tersch, L. W., Electrical Engineering Dept., Iowa State College, Ames, Iowa
Watkins, D. A., 1608½ Washington Ave., S.E., Cedar Rapids, Iowa

Admission to Member Grade

Ankers, R. E., Jr., 1601 N. Rhodes St., Arlington, Va.
Autuori, V. A., 67 Broad St., New York, N. Y.
Barr, E. M., 25 Southland Dr., Henrietta, N. Y.
Beckwith, R. W., 235 Shaver Ave., North Syracuse, N. Y.
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(*Continued on page 44A*)

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Chester, W. G., 913 N. Woodington Rd., Baltimore 29, Md.
Dougherty, J. W., 2617 S. 71 St., Philadelphia 42, Pa.
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Fitzwilliam, J. P., 408 S. 17 St., Manhattan, Kan.
Frias, D. E., Mendoza 223, Tucuman, Argentina
Gensler, E. J., 43 Manhassett St., Buffalo 10, N. Y.
Goldberg, B., 27 Prospect Ave., Atlantic Highlands, N. J.
Gulick, E. C., 166 Earl Lane, Hatboro, Pa.
Hill, F. P., 2641 Elder Lane, Franklin Park, Ill.
Langworthy, R. E., 1879—17 St., Cuyahoga Falls, Ohio
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Lippmann, S. A., 1961 Hazelwood, Detroit 6, Mich.
McMahon, G. V., 453 West 70 St., Chicago 21, Ill.
Montgomery, G. F., 4557 S. Chelsea Lane, Bethesda 14, Md.
Myrbeck, E. R., Cruft Laboratory, Harvard University, Cambridge, Mass.
Nelson, G. R., 306 E. Forrest Lane, Oak Ridge, Tenn.
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Smith, W. N., Osage Rd., Anchorage, Ky.
Stateman, M. J., 415 W. 56 St., New York 19, N. Y.
Zelazo, N. K., 500—18 St., S., Arlington, Va.

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Alexander, J. H., Jr., 219 E. Meyers St., Pittsburgh 10, Pa.
Allen, G. W., 100 Riverside Dr., Riverside 15, R. I.
Ansel, D. E., 4631—37 W. Racine Ave., Chicago 40, Ill.
Appleby, G. E., 1337 N. Dearborn St., Chicago 10, Ill.
Bailey, F. W., 2733 Newell St., Los Angeles 26, Calif.
Behagen, E. L., 3251A N. Fifth St., Milwaukee 12, Wis.
Bell, R. E., 120 W. Maple St., Charlotte, Mich.
Bhatnagar, H. M., c/o The National Radio & Engineering Company, Ltd., 26 Sleater Rd., Bombay 7, India
Bhoumick, N. P., Dept. of Electrical Tech., Science Institute, Bangalore, Malleswaram, Mysore, S. India
Black, T. L., 123 Eldorado St., Syracuse 6, N. Y.
Borgsteadt, J. B., 3364—18 St., N.W., Washington 10, D. C.
Brousseau, A. T., 3364—18 St., N.W., Washington 10, D. C.
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Cecil, J., Box 1072, Midland, Tex.
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Clarke, I. A., 3343 N. Sydenham St., Philadelphia 40, Pa.
Coleman, M. J., 152 Derby St., Johnstown, Pa.
Decker, D. D., 208 N. Mayfield, Chicago 44, Ill.
Denniston, R. L., Box 312, Alamogordo, N. M.
Eastman, C. W., Hq. 59 AACS Group, APO 942, c/o Postmaster, Seattle, Wash.
Edwards, M. W., 31 Longview Ave., White Plains, N. Y.

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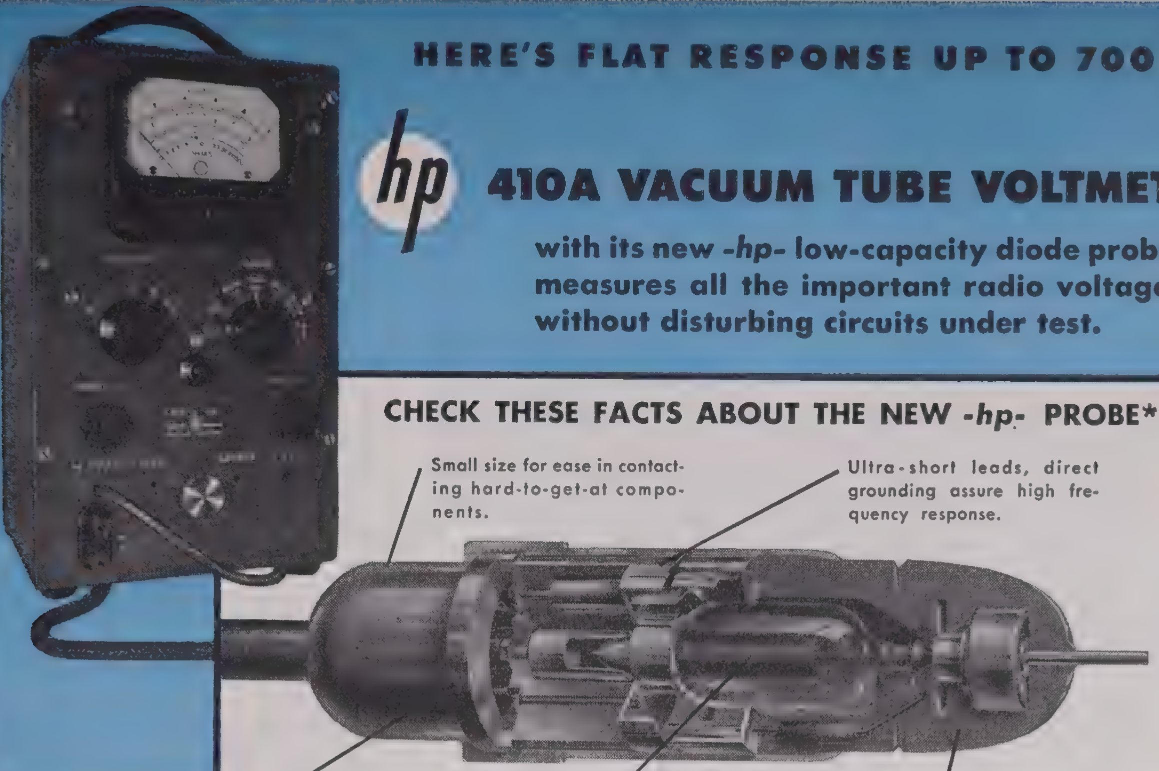

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Ultra-short leads, direct grounding assure high frequency response.

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Specially-designed diode has short transit time, low input capacity, high resonant frequency of 2000 mc.

Detachable tip lowers input capacity, shortens diode lead, utilizes maximum capabilities of diode.

**Reproduced actual size*

The specially-designed diode, in combination with the *-hp-* probe design, makes possible the exceedingly flat frequency response shown graphically in Figure 1.

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In short, this *-hp-* 410A Vacuum Tube Voltmeter is ideal for obtaining most important parameters in radio design, manufacture, or servicing. Write today for full details. Hewlett-Packard Company, 1407D Page Mill Road, Palo Alto, California.

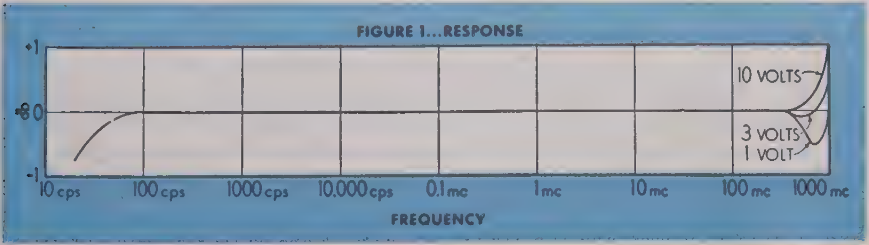

FIGURE 1...RESPONSE

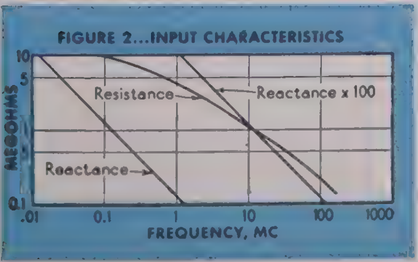

FIGURE 2...INPUT CHARACTERISTICS

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Meter instantly indicates changes in antenna adjustments
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New MODEL 40-C

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An exclusive Andrew feature permits measurement of current ratios and phase angles in degrees on a single meter. This affords immediate observation of the effects of small antenna circuit adjustments.

Sensitivity is high—better than one volt from 550 to 1600 KC.

Six individual input circuits accommodate directional systems utilizing as many as six towers.

Write for Bulletin 47 for full details. Prompt placement of your order will assure delivery when needed.

Many stations already have purchased this new Phase Monitor; among them are:

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Gondek, E. P., 3138 W. Warren Blvd., Chicago 12, Ill.
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Hansen, W. G., 4839 Arvilla Lane, Houston 4, Tex.
Hawley, W. E., 548 W. Spring St., Lima, Ohio
Hennelly, J. P., 6237 S. Normal Blvd., Chicago 21, Ill.
Holt, D. J., 221 E. Lake Dr., Decatur, Ga.
Honer, R. E., 4174 Osborne Rd., Chamblee, Ga.
Huddleston, W. B., 4417 Darsey, Bellaire, Tex.
Hylas, A. E., 29 Lester Ave., Westwood, N. J.
Jacobson, H. R., 4904 William St., Omaha 2, Neb.
Jahnke, C. E., American Television, Inc., 5050 Broadway, Chicago, Ill.
Jenkins, P. M., 1719 Larrabee St., Chicago 14, Ill.
Johnson, C. W., 667 Fellows Ave., Syracuse 10, N. Y.
Johnson, V. N., Box 64, Angola, Ind.
Kauder, A. J., 2214 W. Dunlop St., San Diego 11, Calif.
Kawai, W. T., CCS, GHQ SCAP, APO 500, c/o Postmaster, San Francisco, Calif.
Kitto, C. E., 381 Concord Ave., Toronto 4, Ont., Canada
Klawinski, R. J., American Television, Inc., 5050 Broadway, Chicago, Ill.
Krishnaswamy, P., c/o Kosala, Thyagarayanagar, India Command, Madras 17, India
Kulosa, A., Jr., 4547 N. Drake Ave., Chicago 25, Ill.
Leach, J. A., 141st AACS Sq., Det. 47, APO 239, c/o Postmaster, San Francisco, Calif.
Lehman, H. W., 2410 E. Ave., N.E., Cedar Rapids, Iowa
Leibowitz, S., 86 W. Bowery St., Akron 8, Ohio
Lichty, J. R., Transmitter Division, Electronics Dept., General Electric Co., Syracuse, N. Y.
Lichty, R. E., 205 Normal Ave., Normal, Ill.
Lieberknecht, J. A., 868½ W. 42 St., Los Angeles, Calif.
Lieberman, E., 1612—70 St., Brooklyn 4, N. Y.
Lindberg, E., 221 Lexington Ave., Buffalo 13, N. Y.
Lurion, E., 1344 W. 39 St., Los Angeles 37, Calif.
Makstein, F. I., 3440 Gates Pl., New York 67, N. Y.
Manoogian, H., 20 Fenner, Cranston, R. I.
McCoig, K. W., 97 Spruce St., Ottawa, Ont., Canada
McCormack, T. L., 9 Nashua St., Somerville, Mass.
McGowan, M. L., 2703 Spaulding St., Omaha 11, Neb.
McIntire, O. E., 407 W. South, Angola, Ind.
Miller, J. R., 2752 Meadowbrook Dr., S.E., Cedar Rapids, Iowa
Milstein, E., 7936 S. Kimbark Ave., Chicago 19, Ill.
Mitchell, H. E., Box 72, P.O. Sarina, Nth. Queensland, Australia
Mitra, G. B., 286/A Ras Behari Ave., Calcutta, Ballygunt, India
Morton, R. F., Route 1, Ravenna, Ohio
Nielsen, C. W., 434 Cornell Place, Louisville 7, Ky.
Oakes, H. S., 4222 Westhill Ave., Montreal, Que., Canada
Oursler, D., 6347 Kenmore Ave., Chicago 40, Ill.
Painchaud, P. A., 1035½ Kingston Ave., Los Angeles, Calif.
Pennington, K., 3208 Portland Ave., Louisville 12, Ky.
Peterson, R. M., 509 S.W. Oak St., Portland 4, Ore.
Porter, E. A., 109 Boonton Ave., Boonton, N.J.
Rabe, W. A., Box 238, Angola, Ind.
Rao, V. B. T., Dept. of Physics, Andhra University, Waltair, S. India

(Continued on page 48A)

NOW *One* INSTRUMENT FOR ELECTRONIC MEASUREMENTS

WESTON ELECTRONIC ANALYZER

Incorporating:

1. *A conventional Volt-Ohm-Milliammeter with self-contained power source.*
2. *A high-impedance electronic Volt-Ohmmeter using 115 volt, 60 cycle power.*
3. *A stable, probe-type, Vacuum Tube Voltmeter, for use to 300 megacycles.*

Model 769

Accurate a-c measurements .25 volt to 120 volts, 50 cycles to 300 megacycles.

Extremely small R.F. Probe (3½″ x ¾″ dia.). Probe constants, 5 megohms paralleled by 5 mmfd., approx.

New unity gain d-c amplifier provides absolute stability with line voltage variations from 105 to 130 volts.

D-C Electronic amplifier ranges 3 to 1200 volts at 15 megohms, resistance ranges 3000 ohms to 3000 megohms.

Conventional 10,000 ohm per volt d-c ranges 3 to 1200 volts, 1000 ohm per volt a-c rectifier ranges 3 to 1200 volts.

Resistance ranges 3000 to 300,000 ohms where a-c power is not available.

Entire Model 769 protected from external RF influences.

Uses standard commercial types of tubes replaceable without recalibration.

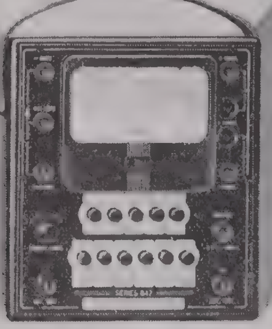
Size only 10″ x 13″ x 6⅛″.

Full details from your local WESTON representative. Literature available . . . Weston Electrical Instrument Corporation, 589 Frelinghuysen Avenue, Newark 5, N. J.

WESTON *Instruments*

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES · MERIDEN · MINNEAPOLIS · NEWARK · NEW ORLEANS · NEW YORK · PHILADELPHIA · PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS · SYRACUSE · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.

SPEED!
ACCURACY!
SIMPLICITY!
EFFICIENCY!



Automatic
PUSH-BUTTON SELECTION

The NEW Precision
Multi-Master
Series 847

5000 and 1000 OHMS PER VOLT
DC—1000 OHMS PER VOLT AC

High speed, 54 range, high sensitivity, AC-DC multi-range tests set. Ranges to 6000 volts, 200 megohms, 12 amperes, + 70 DB.

A rugged, high sensitivity, general purpose AC-DC test set, designed to withstand the continuous use associated with elecronic maintenance and service, classroom instruction, production testing, etc. • 200 microampere, 4⅝" meter. • All standard functions at only two jacks. • 200 megohm insulation resistance test range. • Recessed 6000 volt safety jacks. • Etched-Anodized aluminum panels resistant to moisture and wear. • Conservatively and professionally designed.

RANGE SPECIFICATIONS

★ 24 AC-DC voltage ranges to 6,000 volts at both 5,000 and 1,000 ohms per volt DC. 1,000 ohms per volt AC. Initial range 0-3 volts.
★ 3 DC current ranges to 12 amperes.
★ 6 ohmmeter ranges to 200 megohms.
★ 8 decibel ranges —26 DB to +70 DB.
★ 8 output ranges to 6,000 volts.

MODEL 847-L; modern, shallow, Bakelite laboratory types case $42.90
MODEL 847-P; portable, hardwood case with tool compartment and cover $44.90

(Prices complete with batteries and High-Voltage test leads.)

ASK to see the full "Precision" line of Quality Test Instruments on display at all leading radio parts and equipment distributors. Signal generators, Vacuum Tube Voltmeters, Tube Testers, Multi-range Test Sets, etc. . . .

Write for new Precision 1948 Catalog

PRECISION
APPARATUS CO., Inc.
92-27 Horace Harding Blvd.
Elmhurst 12, N. Y.

Export Division: 458 Broadway, N. Y. City, U.S.A.
Cables: MORHANEX

MEMBERSHIP

(Continued from page 46A)

Redler, W. M., 6602 Connecticut Ave., Chevy Chase 15, Md.
Ritter, F. O., 10-40—117 St., College Point, N. Y.
Rockwell, J. R., 691 Kildare Rd., Windsor, Ont., Canada
Sanders, R. W., 940 E. Seventh St., National City, Calif.
Saulnier, G. S., U. S. Navy Electronics Laboratory, Code 434, San Diego 52, Calif.
Scott, V. J., Jr., 203 Morgan Blvd., Valparaiso, Ind.
Seamans, J. O., 2336 Elizabeth Ave., Winston-Salem 7, N. C.
Shappee, C. E., Route 1, Montpelier, Ohio
Shooner, R. J., 301 Second St., Angola, Ind.
Sloan, A. C., 3743 N. Lawndale, Chicago 18, Ill.
Smith, F. B., Box 255, Piedmont, S. C.
Smith, L. R., 115 N. Denison St., Baltimore 29, Md.
Snow, V. M., 122 W. Kelso St., Inglewood, Calif.
Sreenivasan, A. P., Grandi Nagar, 186, 6th Cross, Bangalore City, Mysore, India
Stavrou, N. C., Box 301, Winston-Salem, N. C.
Stilin, F. L., 28 Grand View Ave., Sault Ste. Marie, Ont., Canada
Swigart, J. W., Box 17, Pleasant Lake, Ind.
Taucer, C. W., 1st Signal Radio Maintenance Sq., Kelly Field, San Antonio, Tex.
Taylor, A. K., 801 Melrose Ave., Verdun, Montreal 19, Quebec, Canada
Taylor, M., Jr., "A" Btry., 571st F.A. Bn., Fort Riley, Kan.
Toner, J. W., 87-04—80 St., Woodhaven 21, N. Y.
Topol, S., 3945 4th St., S.E., Washington, D. C.
Trichinotis, J., 3822 W. Flournoy St., Chicago 24, Ill.
Turner, R., 217 Jerrys Lane, Erdington, Birmingham 23, England
Venkatasubramanian, T. R., 22 Kiladar St., Teppakulam Post, Trichinopoly, India
Viebranz, A. C., Sylvania Electric Prods., Inc., 70 Forsyth St., Boston, Mass.
Walden, L. H., 737 Cornish Dr., San Diego 7, Calif.
Warnick, A., 2745 Richton, Detroit 6, Mich.
Wilhelm, C. J., 4445 S. Talman Ave., Chicago 32, Ill.
Wooley, E. E., Apt. D-2-D, Lacona, Rodman, Panama, Canal Zone
Yoder, J. R., 12 Wenzel Terr., Stamford, Conn.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 22A)

Air Flow Switches

Air Flow Switches are now being manufactured by **Coral Designs**, Box 248, Forest Hills, N. Y., as a standard item, according to a recent announcement.

These switches are used as safety switches to insure against tube failure due to lack of air flow, and they are being employed in 3-, 10-, and 50-kw. broadcast transmitters in which they are used to indicate the resulting static pressure due to impact caused by air flow.

Other units are used not only to indicate air failure, but also to insure proper maintenance and operation of equipment by indicating when a change in static pressure in a system takes place due to conditions created by unclean air filters, failure by personnel to open louvers on ducts leading outdoors, etc.

Installation is very simple, and all units are provided with means of adjustment for regulating the unit for the desired air flow in the field.

MEASUREMENTS
CORPORATION
Model 59

2.2 mc.
to
400 mc.
GRID CURRENT

MEGACYCLE
METER

Radio's newest, multi-purpose instrument consisting of a grid-dip oscillator connected to its power supply by a flexible cord.

Check these applications:

- For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, coils.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

SPECIFICATIONS:
Power Unit: 5⅛" wide; 6⅛" high; 7½" deep. Oscillator Unit: 3¾" diameter; 2" deep.

FREQUENCY:
2.2 mc. to 400 mc.; seven plug-in coils.

MODULATION:
CW or 120 cycles; or external.

POWER SUPPLY:
110-120 volts, 50-60 cycles; 20 watts.

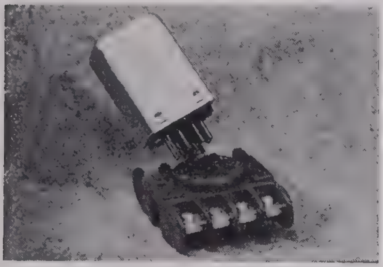
MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Relay Used With Thermostat

A significant application for a low-cost, totally enclosed relay has been reported by the manufacturer, **Sigma Instruments, Inc.,** 70 Ceylon St., Boston 21, Mass.

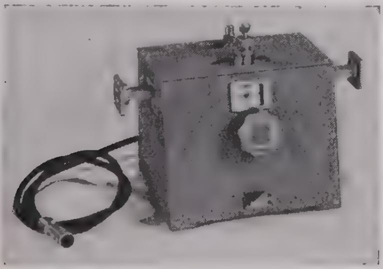


A widely used, effective, and inexpensive means of accurate temperature control consists of a sensitive mercury thermostat which switches the coil circuit of a relay, the relay in turn controlling the load.

The Sigma Series 41 relay is suited for this application. One standard type operates with only 2 ma. at 115 volts a.c. in the coil circuit. The relay contacts are suitable for loads typical of this service, such as solenoid valves, incandescent indicator lamps, and resistance heaters. Replacement after damage or long service is made easy by plug-in mountings. Pictured is the Type 41RO, which weighs only 3 oz. and is 1¼ inches × 1¼ inches × 2 inches high above the base. This relay, in combination with the new Amphenol socket, permits screw connections to the relay.

Standing Wave Detector

Among a series of new developments in the field of electronic test equipment is a standing-wave detector measuring ½×¼ inch, recently introduced by **DeMornay-Budd, Inc.,** 475 Grand Concourse, New York, 51, N. Y.



This new detector operates on the frequency band from 23,000 to 27,000 Mc.

The main block and waveguide extremities are machined from a solid steel block. Square-type choke and cover flanges are used for the two waveguide couplings.

The entire unit is gold-plated over-all, both interior and exterior, and is mounted in a self-supporting cabinet finished in baked wrinkle gray.

(Continued on page 58A)

FOR IMMEDIATE DELIVERY!

INDUSTRIAL and TELEVISION

POCKETSCOPE

MODEL S-II-A

by WATERMAN!

An OSCILLOSCOPE of UNUSUAL VERSATILITY, UTILITY and PERFORMANCE

A 3 INCH OSCILLOSCOPE for MEASURING AC and DC!

$99

F. O. B., PHILADELPHIA

AMPLIFIERS for vertical and horizontal deflection as well as intensity . . . Linear time sweep from 4-cycles to 50-kc with blanking of return trace . . . Sensitivity up to 100 mv/in . . . Fidelity up to 350-kc through amplifiers . . . Attenuators for AC and for DC . . . Push-pull amplifiers . . . Anti-astigmatic centering controls . . . Trace expansion for detail observations.

Chassis completely insulated from input circuits assures safety in industrial applications . . . Direct connections to deflecting plates and intensity grids from rear . . . Retractable light shield . . . Detachable graph screen . . . Handle . . . Functional layout of controls.

COMPLETELY PORTABLE!
8¾ lbs. . . . 11" x 7" x 5"

WATERMAN PRODUCTS
WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.

Sales Engineers Wanted

Leading manufacturer of communications radio equipment requires a number of full-time sales engineers to handle the sale and installation of two-way VHF Mobile radio. Salary plus commissions, with expense allowance. Car and first or second class phone license essential.

The men we want will be capable of earning from $400 to $600 per month, working from their own home.

Please write for personal interview giving details of experience and qualifications.

Box 503
Institute of Radio Engineers
1 East 79th Street
New York 21, New York

Wanted

Engineers Physicists

opportunities for graduate engineers with research, design and/or development experience on radio communication systems, electronics and mechanical aeronautical navigation instruments and ultra-high frequency and Micro-wave Techniques. Write full details to

Personnel Manager
FEDERAL
TELECOMMUNICATION
LABORATORIES
500 Washington Ave.
Nutley, N.J.

ELECTRONICS POSITIONS AVAILABLE

Men with Master's or Doctor's Degrees in Electrical Engineering or Physics, or engineers or physicists with a Bachelor's Degree plus experience in the design or development of electrical and/or mechanical computors, integrators, comparators, gyromechanisms or servomechanisms.

Excellent working conditions.
Salary commensurate with ability.

Call in person or write:

Employment Department
Curtiss-Wright Corporation
4300 East Fifth Avenue
Columbus 16, Ohio

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. . . .

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
I East 79th St., New York 21, N.Y.

PRODUCTION DESIGN ENGINEER

Engineer, preferably with radio-phonograph mechanical design background, capable of producing practical low cost, mass production designs starting from performance specifications. The work involves specification for purchase of components, establishing of inspection and quality standards, coordination of appearance styling, and follow up of initial production. Reply giving a brief résumé of personal data, educational background, and details of type of product worked on, and extent of responsibility over the past ten years. Box 492.

ELECTRONIC THEORIST

Our New York laboratory is seeking an electrical engineer or physicist to carry on theoretical investigations of problems associated with vacuum tubes, thermonics and microwave equipment and to interpret theoretical developments in terms of experimental results. M.S. or equivalent in experience in the field of thermonics and microwave engineering desired. Send résumé outlining age, education, experience, salary requirements to: Supervisor of Employment, Industrial Relations Department, Sylvania Electric Products, Inc., 40-22 Lawrence Street, Flushing, N.Y.

MECHANICAL DESIGN ENGINEER

Having experience in quantity production of small metal stampings and component assemblies. Pleasant working conditions with electronics equipment manufacturer in small Minnesota town. Box 493.

MASS SPECTROMETRY

Engineer with advanced degree and experience in electronics, ion-optics, and high-vacua techniques to take charge of long term program in development and research in field of mass spectrometry at an eastern university. Salary $5,000-$8,000. Box 495.

ELECTRONIC CIRCUIT ENGINEERS

For design, construction and test of electronic circuit components and systems in forms suitable for field operation of a complete electronic field installation. Ingenuity, imagination and capable theoretical inclinations suitable for research laboratory work are desired. Send résumé outlining age, education, experience and salary requirements to: Supervisor of Employment, Industrial Relations Department, Sylvania Electric Products, Inc. 40-22 Lawrence Street, Flushing, New York.

(Continued on page 52A)

Electronics Park, Syracuse, New York

ENGINEERS

The Electronics Department has need for additional experienced engineering personnel for its enlarged operation at Electronics Park.

- **RADAR DESIGN**
- **TRANSMITTER DESIGN**
- **RECEIVER DESIGN**
- **ADVANCED DEVELOPMENT**

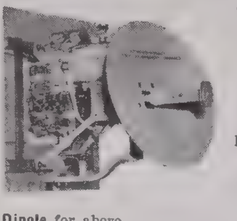
Please forward all inquiries to Personnel Section, Reception Building, General Electric Company, Electronics Park, Syracuse, New York.

All applications confidential

GENERAL ELECTRIC

FINEST QUALITY "Communications" LOWEST PRICES

MICROWAVE ANTENNAS



3 CM. ANTENNA WITH DISH 14½", Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. Complete. New. $65.00

Relay System Parabolic reflectors approx. range: 2000 to 6000Mc. Dimensions 4. -5' x 3' New . $85.00

Dipole for above $5.00

TDY "Jam" Radar rotating antenna, 10cm. 30 deg. beam, 115V AC drive. New $100.00

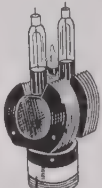
SO Surface Search Radar rotating antenna, 10cm. 24" dish, complete with drive and selsyn motors. New $90.00
Used $45.00

10 Cm Horn, rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange $35.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes .. $20.00

Cone Antenna, AS 125 APR, 1000-3200 mc. Stub supported, with type "N" connector $4.50

MICROWAVE TUBES

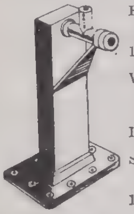


3J31 (1 cm)	$17.50
Magnet for 3J31	8.00
2J32 (10 cm)	25.00
Magnet for 2J32	10.00
2J38 (10 cm) with magnet	37.50
2J55 3 Cm. packaged magnetron, 9345-9405 Mc. 50 KW. Peak Power output. Waveguide output	45.00
WE700A (L band)	45.00
WE720BY (S band) 1000 KW	25.00
2K25-723AB Klystron	7.75
QK 59, QK 60, QK 62. Tunable packaged Magnetrons, 10 cm	ea. 45.00

Small Quantities of Other Types. Write for Information.

MICROWAVE PLUMBING

10 CENTIMETER



Sand Load (Dummy Antenna) wave guide section with cooling fins, app. 23" high	$28.00
Rigid Coax Directional Coupler CU-90/UP 20 DB drop, has short right angle, about 8"	5.50
Coax Rotary Joint with mounting plate	8.00
Dipole Antenna in lucite ball, for use with parabolic.	5.00
Flexible Coaxial Connector, rigid coax to rigid coax ⅞" diam.	2.50
10 CM Dipole and Reflector with type "N" Fitting..	2.75
Waveguide to flexible coax coupler (RG 18 U), with flange. Gold plated. App 10" high	17.50
Rigid coax slotted section CU-60/AP	5.00
Stub-supported rigid coax, gold plated, 5' lengths. Per 5' length	5.00
10 Cm. McNally cavity. Silver Plated. Type SG	3.00 Ea.
Crystal Mixer, "S" Band. Complete with Type "N" fitting and 1N22 crystal	3.85
10 Cm waveguide. 5'9" choke to cover Per section	12.00
Per set of 4 sections	45.00

3 CENTIMETER

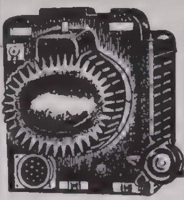
Wave Guide Sections 2.5' long, silver plated with choke flange	$5.75
Wave Guide 90 deg. bend E Plane 18" long	4.00
Wave Guide 90 deg. bend E plane with 20DB directional coupler	4.75
Wave Guide 18" long "S" curve	2.00
Rotary Joint choke to choke	6.00
Rotary Joint choke input; round guide output	5.25
S-Curve Wave Guide 8" long cover to choke	2.50
Duplexer Section using 1B24	10.00
Wave Guide 5' length per foot	1.50
Pick-up loop with adjustable tuning section	1.50
3 Cm Wavemeter Maquire 1528TFX-24GA..	15.00
3 Cm stabilizer cavity, turnable transmission type. Model 1551 (TFX 11 GA)	20.00
3 Cm waveguide. 1⅛" x ½" 15 Ft. lengths available. Per Ft.	1.50

1.25 CENTIMETER

Wave Guide Section 1" cover to cover	$2.00
T Section choke to cover	4.50
Mitred Elbow cover to cover	3.00
Mitred Elbow and "S" sections choke to cover	3.50
Flexible Section 1" long choke to choke....	3.00

CONNECTORS

UG 21/U. Type "N", Male	$ .85
UG 86/U. Gold Plated	.95



PULSE MODULATOR

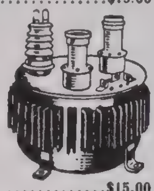
W. E. No. D-151756 Contains multivibrator, amplifier, rectifier; air and oil sections. Designed for 400 cycle operation. Has followlowing tubes;, 1—3E29, 1—6AG7, 1—8016, 1—705A. Size: 18"Lx10"Wx15" H $49.95

PULSE TRANSFORMERS

GE ♯ K 2731

Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK, Sec. Output: 28 KV PK. Peak Output: 1800 KV. Bifilar: 2.75 Amp. $19.50

All Standard name Items



Type G.E. K2450A Will receive 13KV, 4 micro-second pulse on pri., secondary delivers 14KV Peak power out 100KW GE $15.00

HI Volt. Magnetron Input transformer W.E. ♯ D-166173 with cooling fins $12.00

UX 4298E Raytheon Pri. 4 KV. 1 microsecond Sec. 16 KV. 1* amps. Fil pri. 115 v. 400 Cycle. Raltheon $15.00

HI Volt input pulse Transformer W.E. ♯ D169271 .... 9.95

Pulse Input, line to magnetron. G.E. K2748A 12.00

Utah Pulse or Blocking Oscillator Transformer Freq limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛ x 19/32 .... .75

RADAR SETS

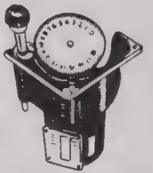
S09-10CM. SURFACE SEARCH 4, 20 and 80 mile ranges Raytheon, 250 KW peak power input to 2J27 magnetron. Complete set including: spare parts, tubes, wave guides and fittings. Send for price and add'l. info.

S013-IDENTICAL TO S09. Complete set, used. Consists of: transmitter and receiver, PPI scope modulator, motor alternator, rectifier, power unit and new rotating antenna $325.00

SN RADAR-GE, low power, 5 and 25 miles ranges. Uses GL464 as pulsed oscillator. 5" "A" scope, "S" band. Extremely compact, ideal for demonstration and laboratory work. 115V 60C operation. Used, Excel. cond. $600.00

140-600 Mc DIRECTIONAL ANTENNA

140-310 Mc cone and 300-600 Mc cone, each consisting of 2 end fed half wave conical section with enclosed matching stub for reactance changes with changing frequency. New, complete with mast, guys, cables, carrying chest $49.50



MICROWAVE TEST EQUIPMENT

Wave guide experimental kit. Consists of: One direct-reading wavemeter, app 2600-3400 mc. (cavity type); One dummy load w/crystal probe. One line stretcher full wave; two wave guide to RG 18/U coax couples: two 1' sections w/flanges complete $250.00

10 CM ECHO BOX, complete with micrometer adjust cavity & resonance indicator. Type TS 238/GP. With calibration chart $105.00

10 CM WAVEMETER, Model "SL". Micrometer adjust cavity with microammeter resonance indicator. Includes 115 VAC operation converter section. In grey metal carrying case, complete with cables & spares. Made by Western Electric $135.00

W. E. I 138-A, Signal generator, 2700-2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00

SPECIALS

10 Cm. RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer $150.00

Modulator-motor-alternater unit for above.. $75.00

Receiver rectifier power unit for above.. $25.00

Rotating antenna using dipole feed and parabolic reflector. New Less Hood $75.00
Used $45.00

RT39APG15 Transmitter-receiver. Lighthouse tube oscillator, .5 KW. App. 2700 Mc. operation. With lighthouse and TR tubes $100.00

WIRE RECORDING MAGAZINES

Magazine for KS 1200 9 recorder, made by W. E. Comes with wire for ½-hour recording. Has elapsed time indicator, recording and erase features. Size 14¾" L x 7" W x 5¾" H. Less Drive Motor $39.50

All merchandise guaranteed. Mail orders promptly filled. All prices, F.O.B. New York City. Send Money Order or Check. Shipping charges sent C.O.D.

COMMUNICATIONS EQUIPMENT CO.

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Digby 9-4124

POSITIONS OPEN

(Continued from page 50A)

ELECTRONIC ENGINEERS

Unusual opportunities for senior engineers experienced in recording sound on film and magnetic tape recording; microwave-antennae, wave guides, mixers, cavity resonators; receiver engineer—design experience in broad band receivers. Radar preferred. Two or three years' experience in U.H.F. work. Outstanding opportunity for top flight men with a small aggressive company. Write Melpar, Inc. Employment Section, 452 Swann Ave., Alexandria, Virginia.

ENGINEER OR PHYSICIST

Engineer or physicist for mathematical research work on vacuum tubes. Should have a good knowledge of microwave tubes and electron optics. Apply Director of Research, 350 Scotland Road, Orange, New Jersey, National Union Radio Corporation.

SCIENTISTS AND ENGINEERS

Wanted for research and advanced development work in the fields of microwaves, radar circuits, gyroscope systems and general electronics. Scientific or engineering degrees required. Salary commensurate with experience and ability. In-

(Continued on page 53A)

INSTRUMENTATION ENGINEERS

Wanted for

PILOTLESS AIRCRAFT, AND GUIDED MISSILE DEVELOPMENT

Must be graduate Engineers with design and development experience in one or more of the following: Miniature or subminiature circuits and assemblies, Sensing and End Instruments, FM, AM, & Pulse Transmitters. Organizing & Supervising ability required. Los Angeles Area. Write complete detail of Education, Experience, and Salary expected.

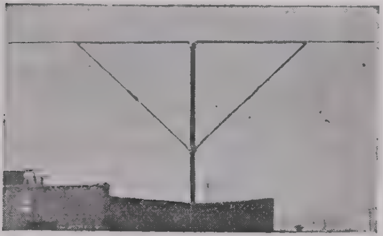
Box 504
The Institute of Radio Engineers
1 East 79th St. New York 21, N.Y.

PREMAX

NOW!

Cover All Frequencies Between 44 and 216 mc. with

One Antenna



A Premax Antenna having a "V" dipole element with extended arms, meets the demand for all TV and FM frequencies from 44 mc. to 216 mc. The dipole elements are of seamless aluminum tubing and assembly fittings are solid aluminum castings. The novel "V" type design allows proper impedance matching to a 300-ohm line.

Total assembled weight with straight-grained hardwood support mast and cross-arm is about 4 pounds.

See it at your radio jobber's. If he cannot supply you, write direct for specifications and prices.

Premax Products
Division of Chisholm-Ryder Co., Inc.

Division Chisholm-Ryder Co., Inc.
4811 Highland Ave. Niagara Falls, N.Y.

POSITIONS OPEN

quiries should be directed to Mgr. Engineering Personnel, Bell Aircraft Corp., Buffalo 5, N.Y.

JUNIOR ENGINEER—Editor and Writer

Excellent opportunity for experienced writer in radio and electronic fields to edit technical publication and handle articles for electronic, broadcast, aviation and amateur radio press. Congenial surroundings in attractive midwest city. Please give full particulars as to background, experience, age and salary in first letter. Collins Radio Company, Cedar Rapids. Iowa.

ENGINEERS AND PHYSICISTS

Several openings available in radar and in medium and ultra high frequency design work, Positions are in an engineering department of a progressive middle western manufacturer. Physicists will find unusual opportunities in the Research Dept. A degree from a recognized engineering college is essential as well as good industrial experience. Address reply to Collins Radio Co., Cedar Rapids, Iowa.

ELECTRICAL ENGINEERS AND PHYSICISTS

An expanding program of teaching and research has created opportunities as instructor, assistant professor, and associate professor level in this large mid eastern college. Your inquiries are invited. Box number 500.

(Continued on page 54A)

PHYSICISTS
ENGINEERS

The establishment of a new section in our research laboratory requires the services of Junior and Senior Electronic Engineers, Servo Engineer and Physicists.

An excellent opportunity to grow with this expanding group and receive responsibility commensurate with your ability.

EMPLOYMENT SECTION

Bendix Aviation Corporation
Research Laboratories
4855 Fourth Avenue
Detroit, Michigan

Something NEW Has been added

PAT. APP. FOR

3 Half Waves in Phase Instead of 2

By adding an additional half wave dipole to its well-known beacon antenna, the Workshop has stepped up the power gain from 2½ to 3½ times that of the ordinary coaxial dipole.

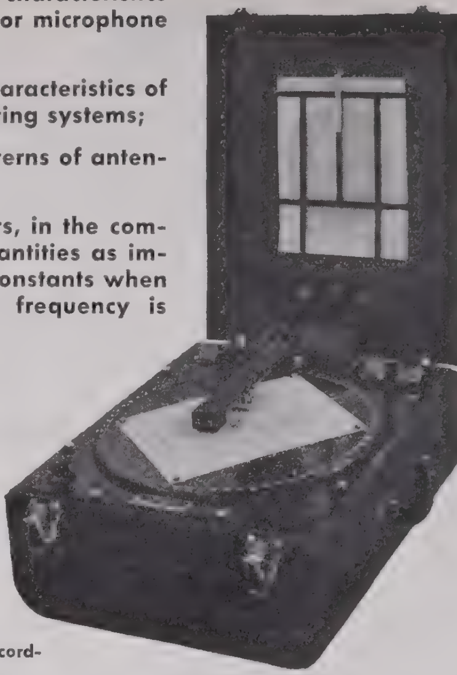
Other new design features include a new molded fiberglass housing for greater strength, less weight, and lower operating losses.

Design Highlights

- Low angle of radiation concentrates energy on the horizon.
- Symmetrical design makes azimuth pattern circular.
- Can be fed with various types of transmission lines. Special fittings are available for special applications.
- Entirely enclosed in non-metallic housing for maximum weather protection.
- Designed specifically for 152–162 mc. with a low SWR over the band.

Available for immediate delivery through authorized distributors or your equipment manufacturer.

THE WORKSHOP ASSOCIATES
INCORPORATED
Specialists in High-Frequency Antennas
66 NEEDHAM STREET
Newton Highlands 61, Mass.



TO PLOT free-field polar characteristics of loudspeaker output or microphone sensitivity;

TO RECORD directional characteristics of lighting fixtures or lighting systems;

TO DRAW directional patterns of antenna system gain;

TO MAKE continuous plots, in the complex plane, of such quantities as impedance and transfer constants when a parameter such as frequency is varied:

USE
Airborne Instruments
Laboratory's Type 116

POLAR RECORDER

IT PLOTS voltage as a radial distance against angular position.

IT IS ADAPTABLE to any task recordable in POLAR COORDINATES.

For Descriptive Material, write:

Airborne Instruments Laboratory
INCORPORATED
160 OLD COUNTRY ROAD · MINEOLA, N.Y.

DIALCO

PILOT LIGHT ASSEMBLIES

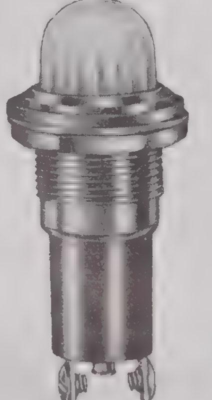
PLN SERIES—Designed for NE-51 Neon Lamp

Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
- 110 or 220 VOLTS
- EXTREME RUGGEDNESS
- VERY LOW CURRENT

Write for descriptive booklet

The DIAL LIGHT CO. of AMERICA
FOREMOST MANUFACTURER OF PILOT LIGHTS
900 BROADWAY, NEW YORK 3, N. Y.
Telephone—Spring 7-1300



POSITIONS OPEN

(Continued from page 53A)

SALES ENGINEER

Manufacturer's representative wants assistant to cover Connecticut territory. Must have sales experience and knowledge of electronic components. Salary, expense allowance and commission. Please furnish complete background information. Box 501.

MECHANICAL ENGINEER

Mechanical engineer to prepare technical manuscripts covering certain operations of the Los Alamos Laboratory. Applicant must have a B.S. degree in mechanical engineering and considerable experience in engineering and technical writing. Interested persons may write directly to Employment Director, P.O. Box 1663, Los Alamos, New Mexico.

ACOUSTICAL ENGINEER

Acoustical engineer wanted with experience in microphones or pickup design. Must know mechanical and acoustical circuits. Write details of experience and education to Engineering Department, Electro-Voice, Inc. Buchanan, Michigan.

ENGINEERS

(1) Mid-western manufacturer has opening for electronic engineer with background in electronic circuit design and instrumentation. Experience with pulse technique, servo-systems or telemetering procedures is desirable. Unlimited opportunity

WANTED PHYSICISTS ENGINEERS

Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or *development experience on radio communications systems, electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.*

WRITE FULL DETAILS
TO
EMPLOYMENT SECTION

SPERRY GYROSCOPE
COMPANY, INC.
Marcus Ave. & Lakeville Rd.
Lake Success, L.I.

Positions Open

in a specialized field. Submit complete résumé and salary desired.

(2) Electrical designer with drafting experience and knowledge of mechanical layout. Experience in design of automatic test equipment desirable. State salary expected.

(3) Electro - mechanical draftsman. Must know symbols and be able to make composite layouts of electrical sub-assemblies. State Salary desired. Write Box 502.

ELECTRONIC ENGINEERS

Opportunity for experienced electronic engineers in established and expanding development company. We design and produce electronic controls and computor equipment. Contact Electronic Associates, Inc., Long Branch, N. J. Telephone L. B. 6-1100 Attention: Mr. Arthur L. Adamson, Personnel Manager.

EXECUTIVE ENGINEER

This notice is inserted by a large manufacturer of radio and television receivers. We have an opening for the one right top executive engineer who really belongs in such an organization. The position is that of heading up all phases of design, development and research engineering. It is probably the toughest engineering chief job in the industry. It pays $25,000.00. Don't waste your time and ours unless you are unqualifiedly sure that you are completely ready for this assignment. Our own key personnel are aware of this announcement. Write to Box 499.

★ ★ ★ ★

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ELECTRICAL ENGINEER

Graduate electrical engineer experienced in development and manufacture of FM and television antennas wishes to associate on an incentive basis with firm interested in manufacture of antenna line. Located in Chicago area. Box 124W.

ENGINEER

B.E.E. June 1948, Ohio State. Experience: 2½ years radio officer U.S. Merchant Marine; 9 months broadcasting station; 7 months FM transmitter; 7 months

(Continued on page 56A)

"Wow-Meter"

Newly developed direct-reading instrument simplifies measurements of variations in speed of phonograph turntables, wire recorders, motion picture projectors and similar recording or reproducing mechanisms.

The Furst Model 115-S "Wow-Meter" is suitable for both laboratory and production applications and eliminates complex test set-ups.

The Model 115-R incorporates an additional amplifier stage so that a direct-ink-ing recorder may be connected for qualitative analysis of speed variations. Send for Bulletin 115.

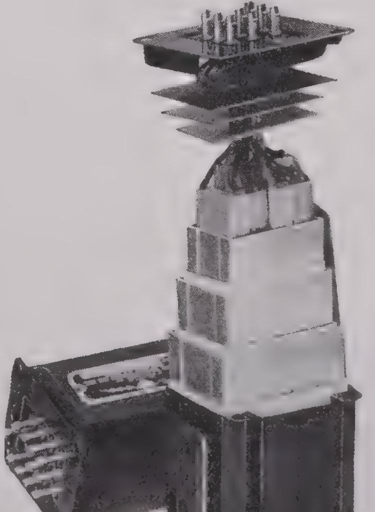
Designers and Manufacturers of Specialized Electronic Equipment

FURST ELECTRONICS

North Avenue at Halsted St., Chicago 22, Illinois

FOR LOW HUM.. HIGH FIDELITY

SPECIFY KENYON TELESCOPIC SHIELDED HUMBUCKING TRANSFORMERS



For low hum and high fidelity Kenyon telescoping shield transformers practically eliminate hum pick-up wherever high quality sound applications are required.

✓ CHECK THESE ADVANTAGES

- ✓ **LOW HUM PICK-UP** . . . Assures high gain with minimum hum in high fidelity systems.
- ✓ **HIGH FIDELITY** . . . Frequency response flat within ± 1 db from 30 to 20,000 cycles.
- ✓ **DIFFERENT HUM RATIOS** . . . Degrees of hum reduction with P-200 series ranges from 50 db to 90 db below input level . . . made possible by unique humbuckling coil construction plus multiple high efficiency electromagnetic shields.
- ✓ **QUALITY DESIGN** . . . Electrostatic shielding between windings.
- ✓ **WIDE INPUT IMPEDENCE MATCHING RANGE.**
- ✓ **EXCELLENT OVERALL PERFORMANCE** . . . Rugged construction, lightweight-mounts on either end.
- ✓ **SAVES TIME** . . . In design . . . in trouble shooting . . . in production.

Our standard line will save you time and money. Send for our catalog for complete technical data on specific types.

For any iron cored component problems that are off the beaten track, consult with our engineering department. No obligation, of course.

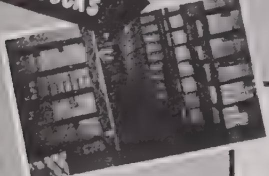
KENYON TRANSFORMER CO., Inc.

840 BARRY STREET NEW YORK, U. S. A.

Your Most Complete Source of Supply for
RADIO and ELECTRONIC
EQUIPMENT • COMPONENTS • ACCESSORIES

is Newark!

TREMENDOUS STOCKS



TRAINED PERSONNEL

No matter what your need — whether Tubes, Components, Test Equipment, Receivers, Transmitters, or Public Address, you can save time and SAVE MONEY by shopping "Newark" first! As one of the largest distributors of radio and electronic components in America, we've got what you want — IN STOCK!

You'll like dealing with "Newark" because —

- Our tremendous stocks of standard brand merchandise always on hand insure speedy shipment of your order.
- Our highly specialized and competent personnel will know what you're talking about.
- Our Special Order Department performs miracles in getting those hard-to-find items that nobody else has!
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MAIL AND PHONE ORDERS FILLED PROMPTLY

Speedy, Efficient Service
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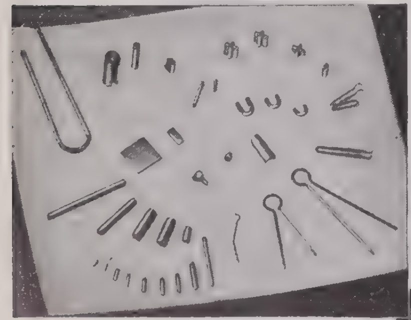
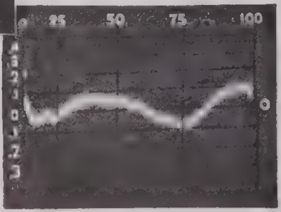
NEY Precious Metals in Industry
for example
WHEN USED AS SLIDING CONTACTS ON POTENTIOMETERS, GREATLY IMPROVED PERFORMANCE MAY BE EXPECTED.



The oscillograph reproduced below shows the excellent linearity obtained when a potentiometer of fine quality was modified by the installation of PALINEY #7 precious metal sliding contacts . . . an improvement from ± .22% to ± .12% was obtained in linearity. Further tests proved that this performance can be held over an extended service life (full test data available on request).



NEY-ORO #28
for Slip Ring Brush Contacts
This is a special alloy developed for use as brush contacts against coin silver slip rings. Laboratory tests and reports from users indicate life of better than 10 million revolutions with no electrical noise.

In addition, Ney offers industrial users a wide range of precious metal alloys for many specialized applications as well as gold solders and fine resistance wires (bare or enameled).

NEY GOLD

Write or phone (HARTFORD 2-4271) *our Research Department.*

THE J. M. NEY COMPANY 171 ELM ST. • HARTFORD 1, CONN.
SPECIALISTS IN PRECIOUS METAL METALLURGY SINCE 1812

Positions Wanted

(Continued from page 55A)

television research. 1st class radio telephone, 2nd class radio telegraph, HAM licenses. Desires electronic research or development work. Vicinity Cleveland or New York City. Box 127W.

ELECTRICAL ENGINEER

Graduate electrical engineer. Age 24. Two years' naval electronic experience. Desires assiting production man in technical duties and paper work. Is ambitious, willing to work hard so eventually can assume duties of production manager. Interviews at your convenience. Box 128W.

ELECTRONIC ENGINEER

Available—Registered electrical engineer. Age 41. 13 years' experience in estimating, supervising and procurement for electrical power construction, designing, developing and specifications for power and electronic equipment. Desires permanent position in design and development for electronic equipment with opportunity for advancement. Box 129W.

ENGINEER

M.S.E.E. in 1947. Single. Age 28. Two years' electronic work in the Navy. Two years teaching. B.S.E.E. in 1942. Prefer development or research. Box 133W.

ADMINISTRATIVE ENGINEER

Relieve top level engineering personnel of technical-administrative duties; 5 years' responsible experience National Bureau of Standards; project coordination and planning; new systems development; preparation of technical reports, engineering specifications; electronics procurement; technical representative for outside contacts. Age 27. Intelligent, initiative, ability to secure cooperation of others. Box 134W.

ENGINEER

B.E.E. New York University, 1944. Age 24. Single. Ex-communications officer. Desires work as executive's assistant or sales engineering in the radio-electronics field. Interesting work and opportunity for advancement primary importance. Box 135W.

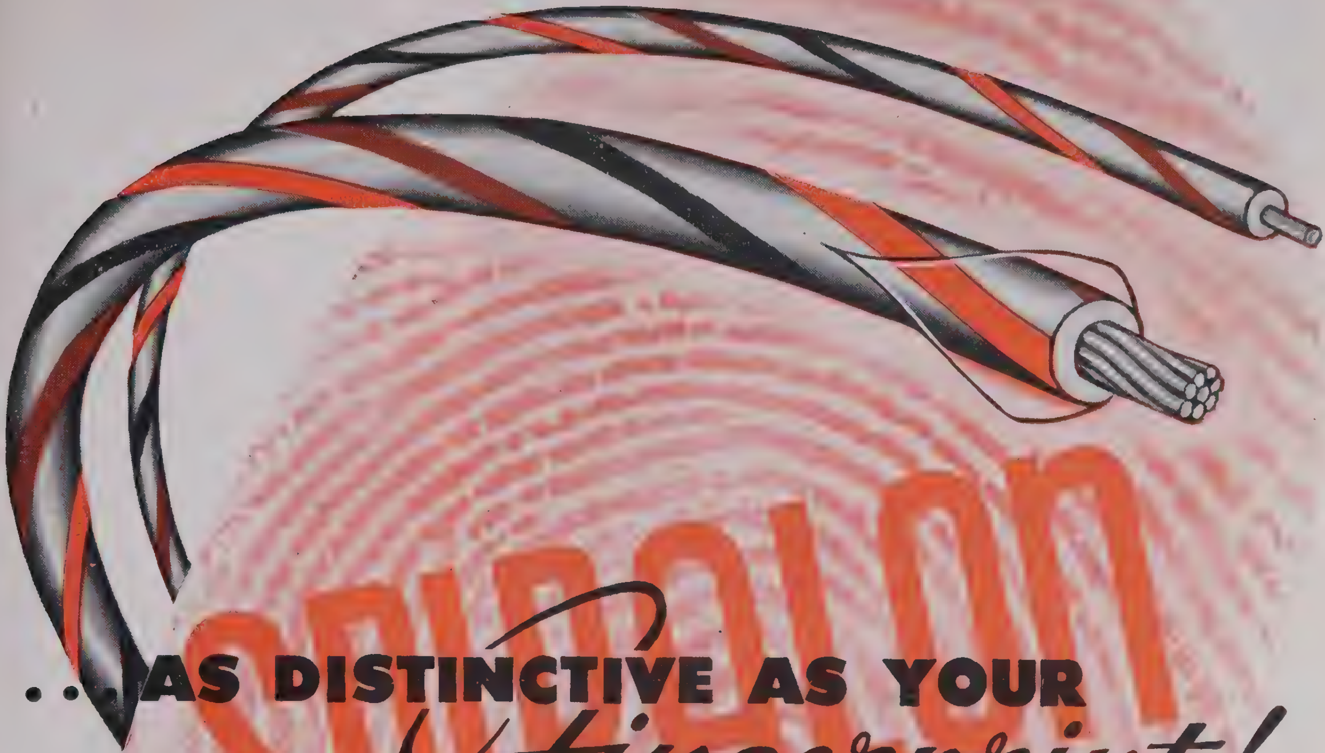
JUNIOR ENGINEER

B.S.E.E. Carnegie Tech. in September 1947. Age 22. Single. 2 years' Navy electronics experience. Desires position in electronics research design or development. Box 139W.

JUNIOR ENGINEER

Graduate of RCA Institutes. Age 27. Married. Desires work in radio, electronics, television production or development anywhere in U. S. 3 years radio work in Army. Box 140W.

PROTECT YOUR FUTURE
BUY YOUR EXTRA SAVINGS BONDS NOW



. . . AS DISTINCTIVE AS YOUR *fingerprint!*

Surprenant's improved SPIRALON is just that! Colors are spirally applied over every inch of its tough, vinyl insulation, furnishing a choice of any one, two, or even *three,* of the nine Army-Navy specified color tracers. These, in turn, provide a total of four colors per wire . . . or a maximum of *eleven hundred and twenty* distinctively coded, solid-color combinations to make identification easy—even in the most complex installations.

Non-inflammable, non-corrosive, flexible and tough under temperature extremes, SPIRALON is obtainable with or without a thin jacket of transparent Dupont nylon to further preserve every electrical property and resist oils, dilute acids, alkalies, abrasion and fungus attack. APPROVED UNDER SPECIFICATION JAN-C-76 Type WL, SPIRALON can't fray, crack or rot—and offers a higher rupture point than braid or lacquers. These superior features are available at no extra cost in all standard wire types and sizes—or carefully manufactured to your most exacting specifications.

Investigate SPIRALON today! Write Dept. G, Surprenant Mfg. Co., 199 Washington St., Boston 7, Mass., for technical data and samples.

SPIRALON "O" (with nylon jacket) ★ SPIRALON (without nylon jacket)

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Pioneers in Plastics Extrusions

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KEYED INSULATION

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S. MFG. CO.

CUSTOM EXTRUDERS, DESIGNERS, FABRICATORS, MANUFACTURERS OF FLEXIBLE PLASTICS PRODUCTS • INSULATED WIRE AND CABLE

FLEXIBILITY
FOR FABRICATION OF SPECIAL
CRYSTAL UNITS
PREPARING SPECIAL CRYSTAL BLANKS FOR MOUNTING

R H

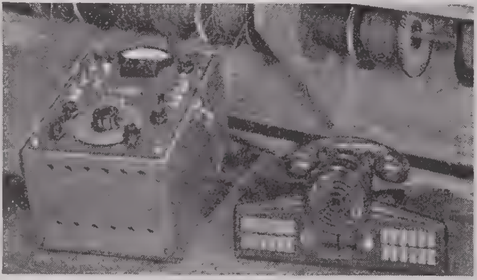
REEVES-HOFFMAN CORPORATION

SALES OFFICE: 215 EAST 91 STREET, NEW YORK 28, N. Y.
PLANT: 321 CHERRY STREET, CARLISLE, PA.

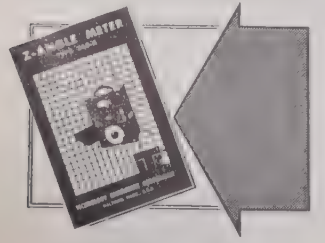
The Z-Angle Meter . . .

ONE OF RAULAND'S MOST WIDELY USED INSTRUMENTS!

At The Rauland Corporation, well-known manufacturers of communication and sound equipment, the Z-Angle Meter is indispensable. Used to measure the impedance of microphones, speakers, and transformers, the Z-Angle Meter has simplified and speeded up testing procedure. J. J. O'Callaghan, Chief Engineer of The Rauland Corporation makes this statement.



"It is so convenient to measure impedance with the Z-Angle Meter . . . it has become one of our most widely used instruments, quickly furnishing a mass of data which previously had taken a great deal of time and effort to accumulate."



If you have a problem in direct measurement of impedance and phase angle at audio frequencies, turn it over to the Z-Angle Meter.

SEND FOR BULLETIN
127 TODAY

ENGINEERING REPRESENTATIVES
CHICAGO: 1024 Superior Street, Oak Park 37, Illinois
Phone: VIllage 9245
HOLLYWOOD: 623 Guaranty Building, Hollywood 28, Calif.
Phone: HOLlywood 5111

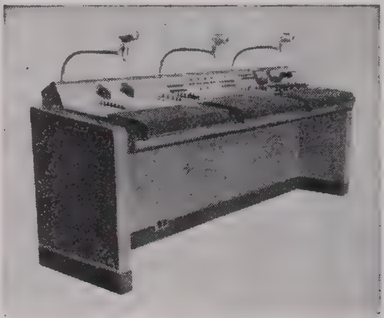
TECHNOLOGY INSTRUMENT CORP.
1058 MAIN ST., WALTHAM 54, MASSACHUSETTS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 49A)

Television Program Console



This new desk-like television program console, containing all the circuits and controls to carry on the necessary supervision and composition of a television program, has been designed by the Transmitter Division, Electronics Dept., **General Electric Co.,** at Syracuse, N.Y.

The new console is divided into three sections for the program director, video operator and audio operator. Communication facilities are provided at each position so that directions may be transmitted to achieve continuity of programming.

Some of the construction details are: elevation to permit full view; internal access accomplished through hinged control surfaces and vertical doors on front face; terminal boards for all external connections; switching, mixing, and fading of any of six channels; and microphones on flexible arms. The console weighs approximately 650 pounds, and is 36½ inches high by 90¾ inches wide by 26 inches deep.

New Wire Recorder

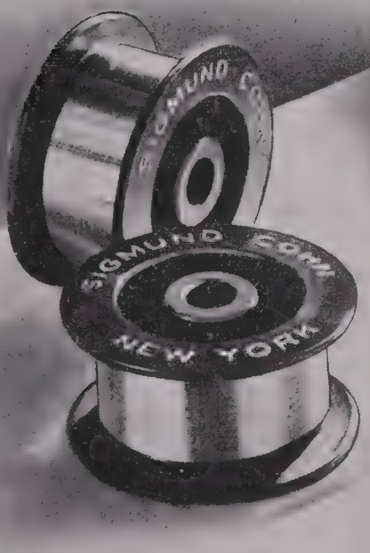
A new high-fidelity wire recorder has been introduced by **Electronic Sound Engineering Co., 4344 W. Armitage Ave.,** Chicago, Ill., and is being sold under the trade name "Polyphonic Sound."

There is available with this recorder a 15-inch, dual-channel auxiliary speaker. This speaker connects with a jack on the front panel and carries the lower range down to 50 c.p.s.

The built-in 6-inch speaker, with a range up to 10,000 c.p.s. has a special diaphragm to insure smooth reproduction of high frequencies.

Input facilities consist of a low-level input for a microphone and a front-panel input arrangement for high-level sound by direct connection with a radio or record player. The microphone has a response of 60 to 10,000 c.p.s. The unit is being manufactured in an optional cabinet of walnut or natural finish birch. Designed for table-top operation, it comes with a portable carrying case.

MICRODIMENSIONAL
WIRE & RIBBON
FOR VACUUM TUBES



Wires drawn to .0004" diameter.

Ribbon rolled to .0001" thickness.

Alloys for Special requirements.

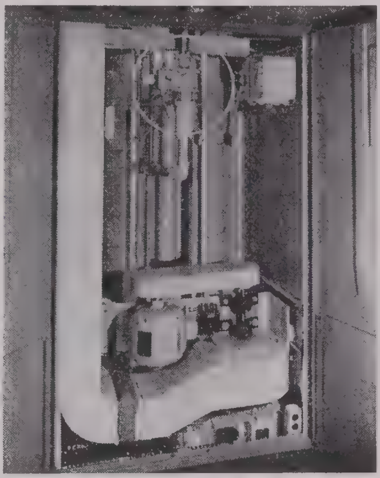
WRITE for list of stock alloys.

SIGMUND COHN CORP.
44 GOLD ST., NEW YORK
SINCE 1901

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

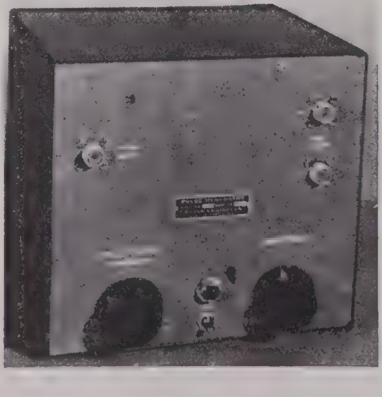
F. M. Transmitter



The 506B-2 10-kw. f.m. transmitter is a unit of the new radio broadcasting equipment of **Western Electric Company,** 195 Broadway, New York, N. Y. The final stage of the transmitter uses a single forced-air-cooled tube. This view, looking through the open rear doors of the center cabinet, shows the 3A power and impedance monitor mounted in the coaxial transmission-line output of the transmitter.

Pulse Generator

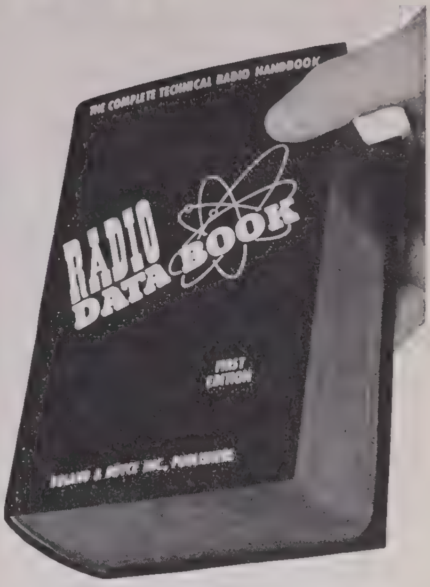
Radar Engineers, Arcade Bldg., Seattle 1, Wash., announce a new pulse generator, Type PG-5, covering a range of pulse widths from 0.1 to 2.0 microseconds with rise and fall times of 0.05 microseconds.



A positive trigger input of from 10 to 20 volts is required for each output pulse, the latter being variable in amplitude from −20 to +20 volts. The unit measures 9×9×10 inches, weighs 12 pounds, and consumes 40 watts at 115 volts, 60 cycles.

(Continued on page 60A)

NOW! *in* 1,000 pages


THE COMPLETE TECHNICAL RADIO HANDBOOK
RADIO DATA BOOK
FIRST EDITION
BOLAND & BOYCE INC., PUBLISHERS

Handsomely bound in RED and GOLD

All data and basic knowledge in radio and electronics digested into 12 sections . . . in a complete, quick to find, easy to read, handbook form.

Plan every operation in radio and electronics with the **Radio Data Book.** This new radio bible will be your lifelong tool . . . you will use it every day, on the board, at the bench, in the field! Use it for construction, trouble-shooting and testing. The RADIO DATA BOOK will be your invaluable aid in design, experiment and in layout. It will help make your production better, faster and easier. In any and every operation in radio and electronics, you will use the RADIO DATA BOOK!

The RADIO DATA BOOK is a work of complete authority, prepared by engineers with many years of practical experience. They have been assisted by the Boland & Boyce staff of editors skilled in preparing electronics manuals for the U. S. Signal Corps for many years. These men have worked for several years gathering material for this book . . . all the knowledge of radio principles and operation . . . all the statistics . . . all the newest developments in electronics . . . every possible angle and detail. Eighteen months were spent digesting this material into the most concise, the clearest, and the most readable form. The result is this invaluable manual . . . The RADIO DATA BOOK. Whether you use this book for general reference, for scientific instruction, or for education, one thing is certain—the practical help, the daily usefulness you will derive from it will prove to be worth many, many times its astonishingly low price!

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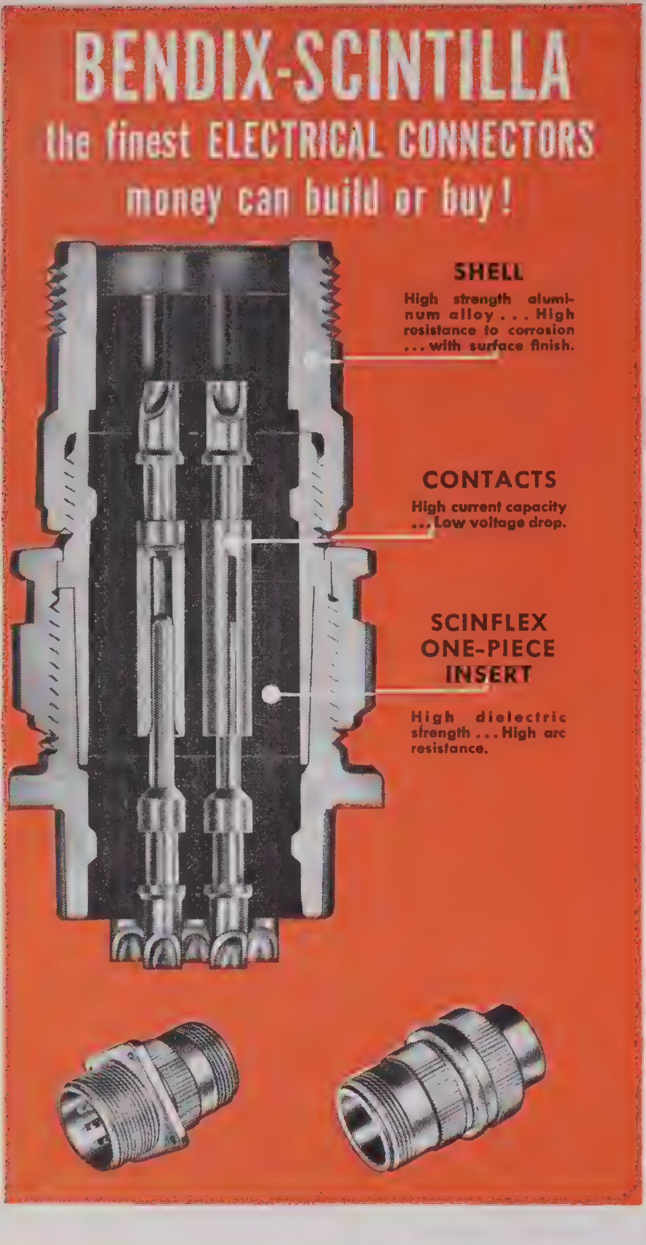
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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

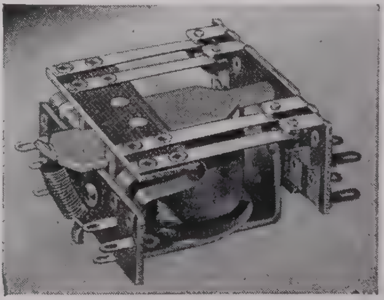
New Test Oscillator

Recently announced by the RCA Victor Division, **Radio Corporation of America**, Camden, N. J., a new portable test oscillator, designated Type WR-67A, is claimed to be the first of its kind to provide three fixed frequencies for high speed servicing of superheterodyne and t.r.f. receivers. The three channels provide the necessary aligning signals without need for adjusting the tuning controls: 455kc. for i.f. channels; 600 kc. and 1500 kc. for r.f. local-oscillator circuits.

The WR-67A is housed in a blue-gray hammeroid case, and is styled with a brushed, anodized aluminum panel. It measures 13½ inches long, 9¾ inches high, and 7½ inches deep, and weighs 15 pounds.

New General-Purpose Relay

Comar Electric Co., 2701 Belmont Ave., Chicago 18, Ill., recently announced their new multi-purpose Type "C" Relay, designed for general circuit-control applications.



According to the manufacturer, this new relay has been specially engineered to provide high efficiency at low cost and is readily adaptable to a wide range of relay requirements. A single screw mounting simplifies coil removal. Average coil consumption, 7½ va. Contact current capacity, 5 amperes at 115 volts a.c. Available in any Contact arrangement up to 4-pole double-throw. Supplied with fine silver contacts or other specified material. Weighs only 3 ounces.

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News—New Products

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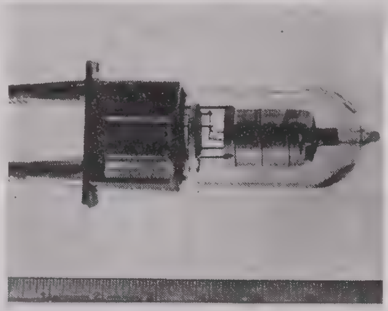
High-Altitude Vacuum Tube

A new vacuum-tube design for use on high voltages at altitudes up to 60,000 feet has been announced by **Amperex Electronic Corp.**, 25 Washington St., Brooklyn, N.Y. The development work was sponsored by the Air Materiel Command of the U. S. Army Air Forces, and the tube is especially important in control circuits of guided missiles.



The base of the tube is of glass and is tapered and ground to fit the socket like a glass bottle stopper. This construction excludes all air, which, a high altitude, causes flash-over between terminals.

The original tube, a high-vacuum half-wave rectifier rated at 14,000 peak inverse volts, can deliver an average plate current of 125 ma. and a peak plate current of 750 ma. Although rated only 14,000 volts peak, this tube-socket combination will handle voltages as high as 35,000 volts peak.

The new design is applicable to all types of high-voltage vacuum tubes which may be subjected to similar high-altitude conditions. When used in areas which are strongly radioactive, tubes of this type will not break down externally due to ionization.

New u.h.f. Tube GL-5648

A new electronic tube to perform at frequencies up to 2500 Mc. under full plate input, Type GL-5648, has been developed by the Tube Division of **General Electric Co.**, Electronics Department, Schenectady, N. Y., for commercial radar, f.m. and television, and studio-to-transmitter link applications.

A forced-air-cooled triode of "lighthouse" design, the new u.h.f. tube for oscillator service and grounded-grid power amplifier applications has a cathode voltage of 6.3 volts. Its interelectrode capacitances: grid-cathode, 7.25 $\mu\mu$fd; grid-plate, 1.95 $\mu\mu$fd; cathode-plate, 0.035 (max) $\mu\mu$fd.

Maximum ratings of the GL-5648 under Class-C telegraphy conditions include a d.c. plate voltage of 1000 volts and plate input of 100 watts. When used as a grid-separation oscillation at 500 Mc. the new tube offers a power output of 25 watts.

(Continued on page 62A)

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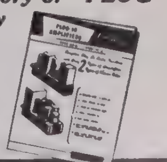

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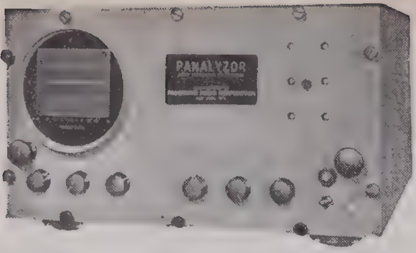

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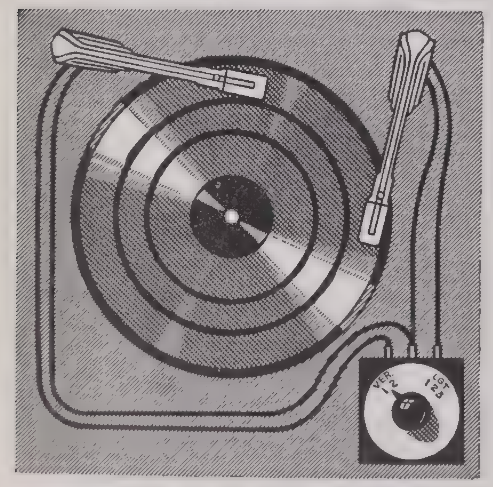

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News—New Products

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(Continued from page 61A)

Dual-Beam Cathode-Ray Oscillograph

A new Type 279 dual-beam cathode-ray oscillograph is announced by **Allen B. DuMont Laboratories, Inc.,** Instrument Division, Clifton, N. J.

This instrument features the two-gun Type 5SP-A cathode-ray tube containing two separate and completely independent electron guns. The oscillograph provides each gun with separate controls for intensity, focus, and X-, Y-, and Z-axis modulations.

A power source of 115/230 volts, 50–60 cycles, operates the instrument. Power consumption is 300 watts. Over-all dimensions are: 22⅝ inches wide, 17¾ inches high, 22⅜ inches deep. Weight is 125 pounds. It is housed in a gray-wrinkle, rack-type cabinet.

Alternating-Voltage Comparator

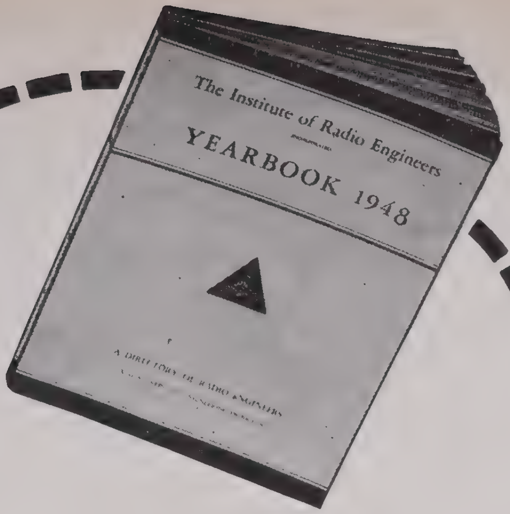
This instrument, which functions at any frequency between 50 and 1,250 c.p.s., is of significant interest to research laboratories, engineering schools, standardizing agencies, electrical testing laboratories, power companies, and manufacturers of electromechanical and electronic equipment.

The availibility of the alternating-voltage comparator was recently announced by **Arma Corporation,** 254–36th St., Brooklyn 32, N.Y., in a statement issued by Herbert C. Guterman, president of the corporation. It was developed during the war to make possible the high accuracy of fire-control computers, and is now offered commercially to other firms.

The manufacturer claims that with the Arma alternating-voltage comparator laboratory measurement of a.c. voltage and phase angle can be made with an accuracy of 1 part in 50,000.

Range of application of this instrument includes the measurement of vectorial ratios essential to computer development; transformation ratio of transformers and networks; power factor of transformers; power factor and Q of resistors, capacitors, and inductors; capacitance or inductance, by reference to a suitable standard; ratio of two currents; and power factor of a.c. machines. It is a complete, self-contained electronic measuring instrument.

(Continued on page 66A)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- ( ) 64. **Switches:**
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  - ( ) b. Key.
  - ( ) c. Power.
  - ( ) d. Receiver Wave Band Changing.
  - ( ) e. Rotary.
  - ( ) f. Time Delay.
  - ( ) g. Transmitter Wave Band Changing.
- ( ) 65. **Testing & Measuring Equip.:**
  - ( ) a. Bridges.
  - ( ) b. Capacitor Testing.
  - ( ) c. Inductance & "Q" Testing.
  - ( ) d. Resistance Testing.
  - ( ) e. Vacuum Tube Testing.
  - ( ) f. Wave Form Analyzers & Distortion Testing.
- ( ) 66. **Transformers:**
  - ( ) a. Audio Frequency.
  - ( ) b. Hermetically Sealed Types.
  - ( ) c. High Fidelity Audio Types.
  - ( ) d. Power Components.
  - ( ) e. Pulse Generating Types.
  - ( ) f. Radio Frequency.
- ( ) 67. **Transmitters:**
  - ( ) a. Amplitude Modulation.
  - ( ) b. Communication.
  - ( ) c. Freq. Modulation.
  - ( ) d. Police & Emergency.
  - ( ) e. Television.
  - ( ) f. Ultra-High Freq.
- ( ) 68. **Ultra-High Frequency Equipment & Accessories:**
  - ( ) a. Antennas & Reflectors.
  - ( ) b. Measuring & Testing. Equipment.
  - ( ) c. Tuning Elements.
  - ( ) d. Wave Guides.
- ( ) 69. **Vacuum Tubes:**
  - ( ) a. Cathode Ray.
  - ( ) b. Geiger Mueller.
  - ( ) c. Industrial Types.
  - ( ) d. Klystrons & Magnetrons.
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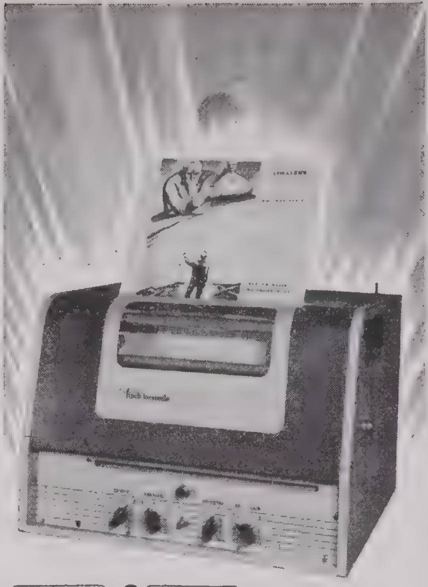

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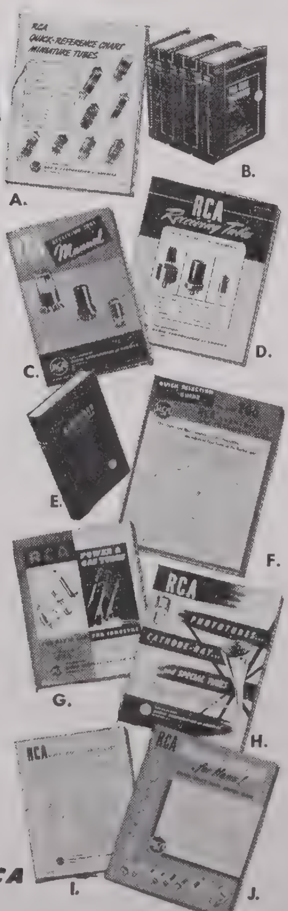
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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 62A)

Magnetic Tape Recorder

The new Model 900D *Magnetape* Recorder, now being produced by the Magnephone Div., **Amplifier Corp. of America,** 398-1 Broadway, New York, N. Y., is providing business organizations with uninterrupted telephone monitoring for a full 8-hour day, and is being used for prolonged radio-broadcast monitoring.

Advanced design principles provide a constant tape pull regardless of build-up in the take-up reel. A mechanical feature is the constant speed drive attained through a special type of synchronous motor employed to drive a combination flywheel and capstan pulley which keeps the tape feeding at an unvarying speed.

The manufacturer states that reels can be played back a thousand times with no loss of fidelity; reels can be erased, and rerecorded again and again; reels can be edited, with unwanted sections cut out, and the tape spliced with ordinary scotch tape.

By utilizing an optionally available built-in automatic program timer, 32 quarter-hour programs may be automatically recorded on a single reel.

This unit features a choice of response ranges from 70 to 9000 cycles for $3\frac{1}{2}$ hours of play at a tape speed of $7\frac{1}{2}$ inches per second; 80 to 5000 cycles for 6 hours of play at a tape speed of 4 inches per second; and 100 to 3500 cycles (voice recording) for 8 hours of play at tape speed of 3 inches per second.

* * *

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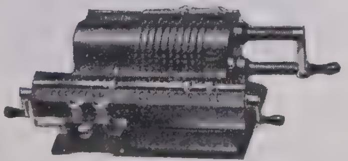

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News—New Products

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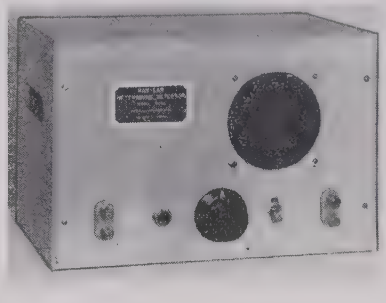
Heterodyne Detector

In announcing a new heterodyne detector which features high sensitivity and a wide frequency range, the **Kalbfell Laboratories, Inc.,** 1076 Morena Blvd., San Diego 10, Calif., claim that the instrument will measure signals of 100 microvolts and is usable from 500 cycles to 50 Mc. Dr. Kalbfell explains that this wide frequency range is possible because no r.f. amplification is employed.

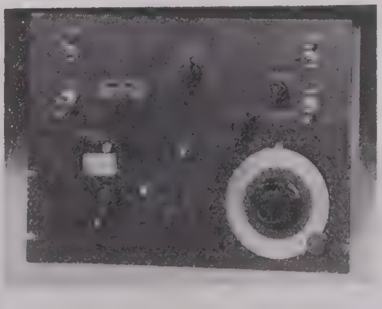


The heterodyne detector is used to compare an unknown frequency with that of a signal generator. This system permits the comparison of fundamental frequencies over the entire range, thereby eliminating the ambiguity which often exists in heterodyne frequency meters operating from harmonics of a narrow-band built-in oscillator.

In addition to measuring frequency, the detector will also demodulate an amplitude-modulated signal, without the use of a second oscillator. The circuit consists of a pentagrid converter and a high-gain audio amplifier with loudspeaker.

Capacitance Bridge

Designed by **General Radio Co.,** 275 Massachusetts Ave., Cambridge, 39, Mass. to fill the gap between a.f. bridges and r.f. types, the new Type 716-C Capacitance Bridge measures capacitance and dissipation at all frequencies between 30 cycles and 300 kc.



Aside from its common use in the measurement of capacitors, this wide-

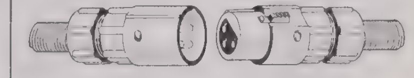
(Continued on page 68A)

RCA STANDARDIZES ON "XL" PLUGS

. . . for popular microphone models such as the "Announce" (Type KN-1A) (shown above), Junior Velocity (MI-4036), Aeropressure (MI-6026, MI-6027), Program Velocity (MI-12002, MI-12003), Aerodynamic (MI-6226, MI-6228), because Cannon XL's are quality plugs, yet in the moderate price class and available everywhere.

The RCA Junior Velocity Microphone, a low cost, lightweight model is equipped with XL-3-12 for speedyinterchange of cable.

RCA is a big user not only in the XL but also the Cannon "P", DP, "K" and "AN" series in many types of equipment. Cannon's reputation for quality



XL-3-12 PLUG LIST $1.20

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and dependability is assured in RCA equipment fitted with Cannon Plugs.

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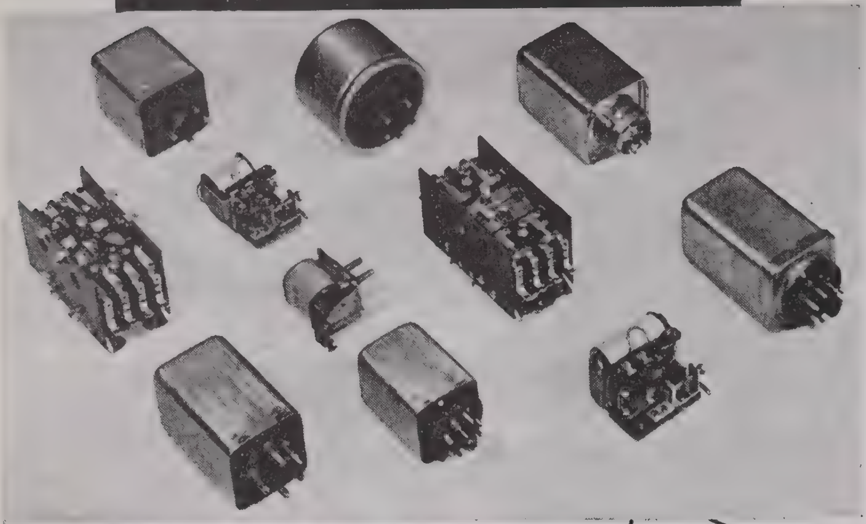

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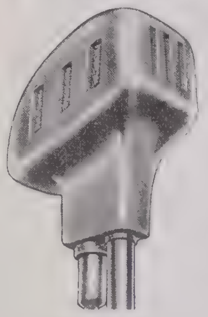

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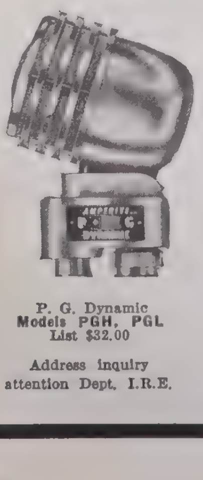

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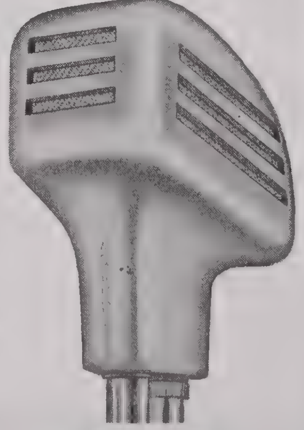

Velocity Microphones for Public Address
Models RBHG, RBLG
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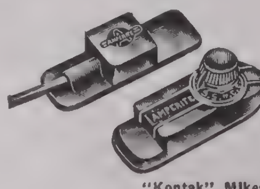

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

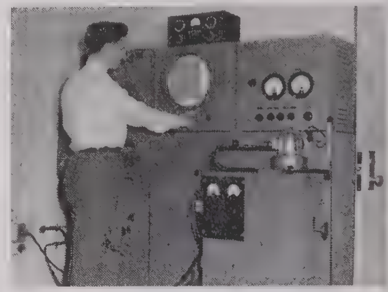
(Continued from page 67A)

frequency-range capacitance bridge is particularly suited for the measurement of dielectric constant and dissipation factor of dielectric materials as a function of frequency. The frequency range covered is sufficient to show the effects of interfacial polarization at low audio frequencies and of dipole dipolarization in polymers. The effect of surface water films on insulators can be measured, as can the Boella effect in resistors.

Supplied in a walnut cabinet, the weight is $53\frac{3}{4}$ pounds; or, for rack mounting, the bridge weighs $41\frac{1}{2}$ pounds. Write to the manufacturer for further information.

New Spectroradiometer

Mass production of luminescent materials, used as the coating on viewing screens of television cathode-ray tubes, is tremendously stepped-up by a remarkable test instrument, according to the RCA Victor Division, **Radio Corporation of America,** Camden, N. J.



The Spectroradiometer, now in use at RCA's plant at Lancaster, Pa., is shown being demonstrated by its designer and builder, Austin E. Hardy, head of the Physical Testing Laboratory in the Lancaster plant, where test batches of luminescent materials are precisely analyzed by this instrument to insure lifelike reproduction of television pictures.

Small-Size Relay Delivers Extreme Output

Developed recently by **Allied Control Co.,** 2 East End Ave., New York 21, N. Y., the BO Power Relay is claimed to be one of the smallest relays giving the greatest output, and tests indicate that it has good mechanical and electrical life.

This multipurpose relay was designed for convenience of wiring, together with small mounting area; and its applications are widened by the fact that the BO is available for either a.c. or d.c. coil operation. Contact arrangement provides double-pole, double-throw or double-break with $\frac{1}{2}$-inch contacts rated at 15 amperes.

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News—New Products

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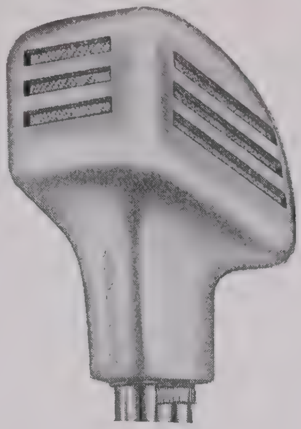
Velocity Microphone

A new velocity microphone for public address is now being manufactured by **Amperite Co., Inc.**, 561 Broadway, New York 12, N. Y.



It is claimed that this new design incorporates all the advantages of a ribbon microphone and eliminates the few causes of dissatisfaction. The manufacturer states, for example, that it will give high-fidelity top-quality reproduction on either close talking or distant pickup; that performers may shout directly into the new microphone without "blasting" effects in the reproduction; and that there is very little difference in pickup as a performer pulls away from the instrument.

The entire microphone has a frequency response of 50 to 11,000 c.p.s. ±2 db. Output is −62 db.

NOTICE

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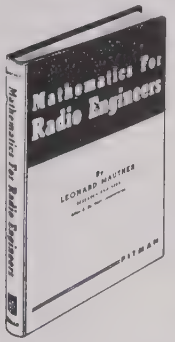
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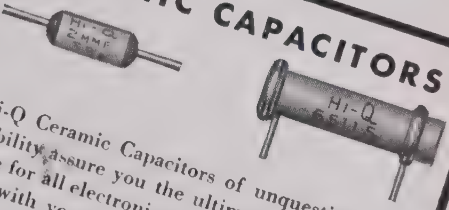

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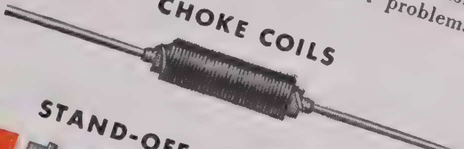
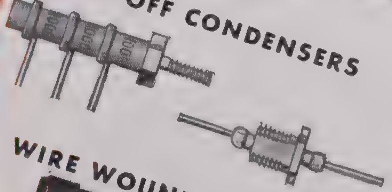
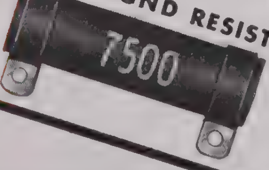


STAND-OFF CONDENSERS



WIRE WOUND RESISTORS



HI-Q COMPONENTS BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble free performance. Our Hi-Q makes your product better.

SPACE SAVING The smallest SIZE VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

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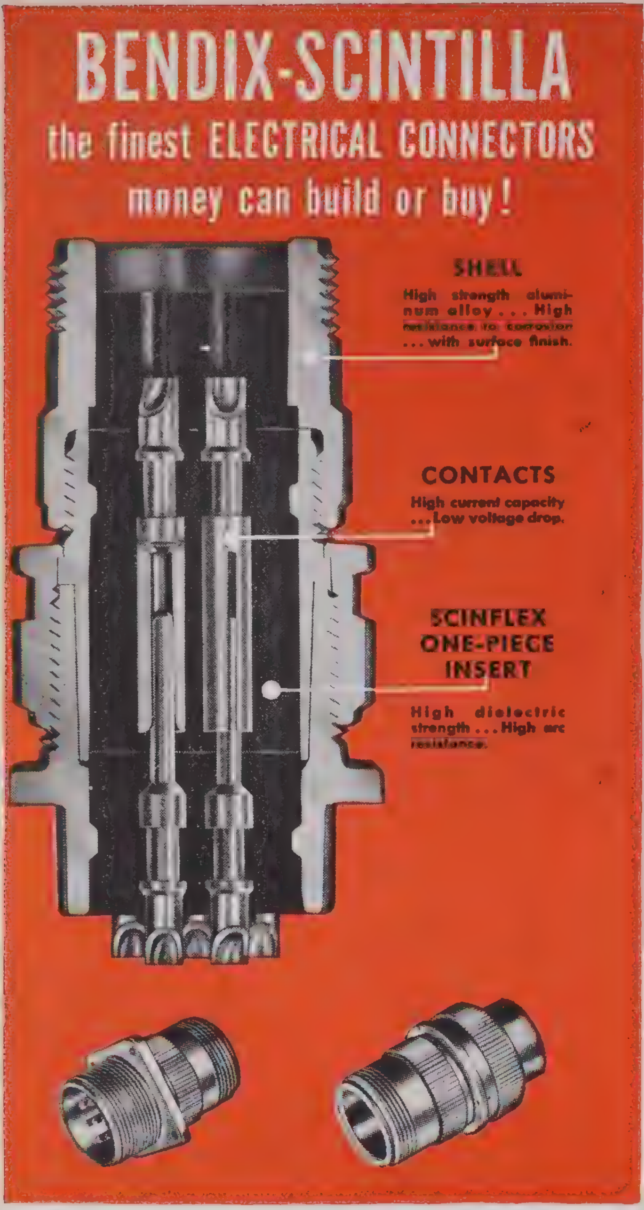
Plants: FRANKLINVILLE, N. Y. — JESSOP, PA.
Sales Offices: BOSTON, NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES


BENDIX-SCINTILLA
the finest ELECTRICAL CONNECTORS
money can build or buy!
SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High arc resistance.

AND THE SECRET IS SCINFLEX!

Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—an exclusive feature that means lower maintenance cost and better performance.

*REG. U.S. PAT. OFF.

Write our Sales Department for detailed information.

- Moisture-proof, Pressure-tight • Radio Quiet • Single-piece Inserts • Vibration-proof • Light Weight • High Arc Resistance • Easy Assembly and Disassembly • Less parts than any other Connector

Available in all Standard A.N. Contact Configurations

BENDIX SCINTILLA
SCINTILLA MAGNETO
SIDNEY, N. Y.
DIVISION OF
Bendix
AVIATION CORPORATION

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Automatic Scaling Unit

A new scaling device for use with Geiger-Muller counters in radioactivity research has been announced by **Instrument Development Laboratories,** 223 West Erie St., Chicago 10, Ill. Known as Model 163, it incorporates facilities for predetermined count and predetermined time operation, in addition to the basic functions which were found in the older model.

This new scaler operates on impulses from a Geiger-Muller tube and actuates a register once for each group of impulses it receives. Scaling factors of 2, 16, 32, or 64 can be used when desired.

A new switch allows the selection of 10, 100, or 1000 times the selected scaling factor for any predetermined count. The scaler will automatically shut off after this predetermined number of counts has been recorded, up to a maximum of 64,000, and will indicate the time required for these counts if connected to an electric timer.

Mega-Marker

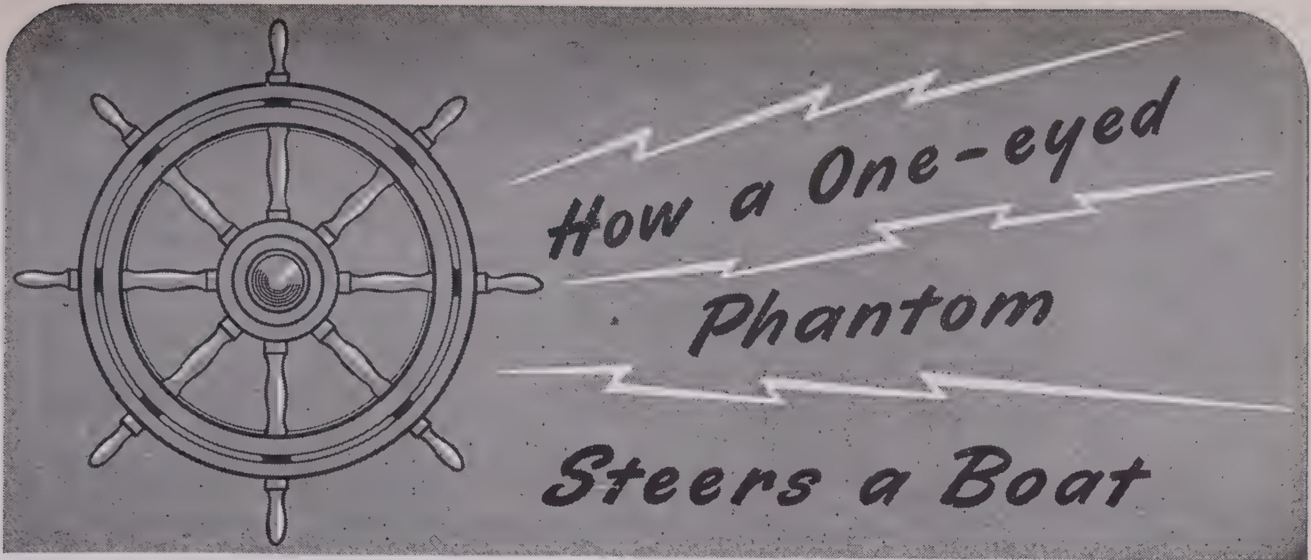
The **Kay Electric Co.,** 34 Marshall St., Newark N. J. has announced the Mega-Marker which is a precision variable marker-oscillator which covers a range of 19 to 29 Mc. for the television i.f. band. For the f.m. i.f. band (10.7 Mc.) a crystal oscillator is incorporated.

MEGA-MARKER
KAY ELECTRIC CO
NEWARK N.J.

Accuracies of 0.02 Mc. may be read off because more than 12 inches of calibrated scale length is provided on the dial.

The Mega-Marker is a valuable accessory for f.m. and television applications of the Mega-Sweep sweeping oscillator, and the Mega-Match for measuring reflected energy.

(Continued on page 48A)



INCO Nickel Alloys help this new robot pilot "see" and correct tiny deviations from course

Plunging through rough seas . . . with no hand at its helm . . . a ship equipped with a Kirsten Photo-Electric Pilot clings to its course with uncanny accuracy.

This robot, manufactured by the Marine Division of the Kirsten Pipe Company, Seattle 9, Washington, gets its initial signal from an electric eye in the compass binnacle.

The slightest deviation of the compass increases or decreases the intensity of a beam of light. This energizes a power unit which, in turn, operates the steering mechanism.

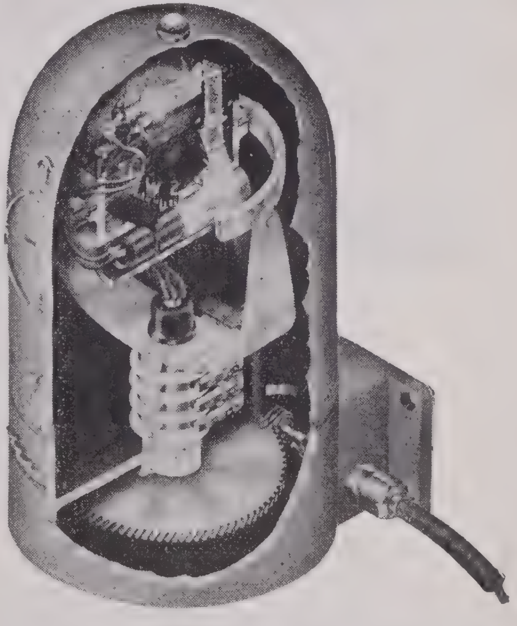
In designing their power unit, Kirsten ran into trouble with the solenoid shaft.

This vital part had to be non-magnetic, strong, and able to take a high polish to cut down friction between the shaft and the steel clutch. It had to be easy to machine and capable of resisting corrosive marine atmospheres.

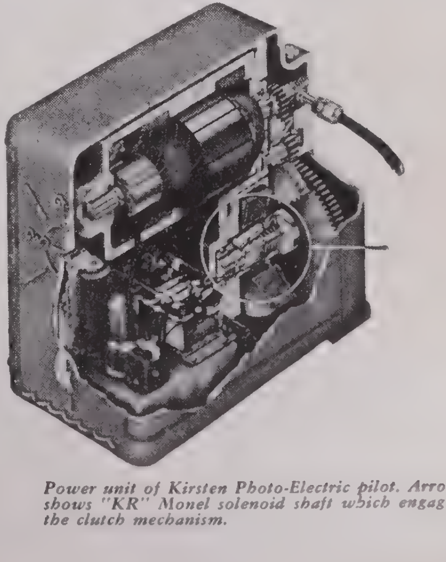
After experimenting with many metals, Kirsten engineers finally found the one with *all* the properties required. Its name? "KR"* Monel.

Also, when perfecting their binnacle unit, these men chose another INCO Nickel Alloy . . . "K"* Monel. Ball bearings of this strong, extra-hard, corrosion-resistant metal enable the binnacle assembly to move freely and easily . . . despite constant wear, damp sea air, and changing temperatures.

Find out where and how one or more of the family of INCO Nickel Alloys can help *you* solve metal-selection problems. Put these alloys at the top of the list when you're searching for metals with a hard-to-find combination of properties.



Section of Kirsten Photo-Electric binnacle. The compass assembly rotates on hard, corrosion-resistant "K" Monel ball bearings. Robot pilots such as these are used today on commercial and pleasure craft up to 100 ft. in length.



Power unit of Kirsten Photo-Electric pilot. Arrow shows "KR" Monel solenoid shaft which engages the clutch mechanism.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
INCO
TRADE MARK

MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL
INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL *Reg. U.S. Pat. Off.

HIGH EFFICIENCY
at HIGH POINT, N. CAROLINA

WHPE-FM USES A **TRUSCON** Self-supporting **RADIO TOWER** **310 FT. HIGH**

AS FM INCREASES in popularity, so does the demand for the efficiencies of Truscon radio tower construction. This new 310 feet Truscon structure at High Point, N. C., has a GE 6-bay circular FM antenna.

More and more the landscape is becoming dotted with Truscon Radio Towers serving both the AM and FM needs of the broadcasting industry.

Truscon can engineer any type of tower you desire . . . guyed or self-supporting, either tapered or uniform cross-section . . . tall or small . . . AM or FM. Truscon engineering consultation is yours without obligation. Write or phone our home office at Youngstown, Ohio or any of our numerous and conveniently located district sales offices.

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YOUNGSTOWN 1, OHIO
Subsidiary of Republic Steel Corporation

Manufacturers of a Complete Line of Self-Supporting Radio Towers . . . Uniform Cross-Section Guyed Radio Towers . . . Copper Mesh Ground Screen . . . Steel Building Products.

SECTION MEETINGS

ATLANTA

"The Coaxial Cable Carrier System," by R. D. Trammell, American Telephone and Telegraph Company; November 28, 1947.

BALTIMORE

"Some New Developments in Atomic Power," by R. Fowler, Johns Hopkins University; December 16, 1947.

BEAUMONT-PORT ARTHUR

"F.M. Detector Systems," by C. V. Clark, Jr., Station KXYZ; October 22, 1947.

"F.M. versus A.M.," by G. K. Miller, Schlumberger Well Surveying Corporation; November 20, 1947.

"Ultra-High Frequency Construction and Operating Techniques," by J. Reinartz, RCA; December 11, 1947.

BOSTON

"Superregeneration," by H. Stockman, S. H. Chang, and H. A. Glucksman, Cambridge Field Station AMC; December 18, 1947.

CEDAR RAPIDS

"Radio-Frequency Heating," by L. A. Lattauzeo, Westinghouse Electric Corporation; December 10, 1947.

Election of Officers; December 10, 1947.

CHICAGO

"Automatic Control in High-Frequency Heating," by E. Mittelmann, Consultant; October 17, 1947.

"Comparative Analysis of Oscillator Circuits for High-Frequency Industrial Generators," by R. A. Whiteman, Consultant; October 17, 1947.

CINCINNATI

"A Broad-Band High-Fidelity Modulator for A.M. Transmitters," by R. J. Rockwell, Crosley Broadcast Corporation; December 16, 1947.

CONNECTICUT VALLEY

"Broad-Band V.H.F. Antennas for F.M. and Television Receivers," by A. Alford, Andrew Alford Consulting Engineers; December 18, 1947.

DAYTON

"A Few Special Developments," by E. D. Cook, General Electric Company; December 11, 1947.

DES MOINES-AMES

"The Origin of Cosmic Rays," by W. W. Salisbury, Collins Radio Company; December 16, 1947.

DETROIT

"Controlled Approach Landing Systems," by A. B. Denicke, Airways Operations Service, Civil Aeronautics Administration; November 4, 1947.

"Atomic Energy—Tool or Weapon," by J. E. Reilly, Westinghouse Electric Corporation; November 21, 1947.

"The General Electric Variable Reluctance Pickup," by F. R. Walker, General Electric Company; December 12, 1947.

Election of Officers; December 12, 1947.

KANSAS CITY

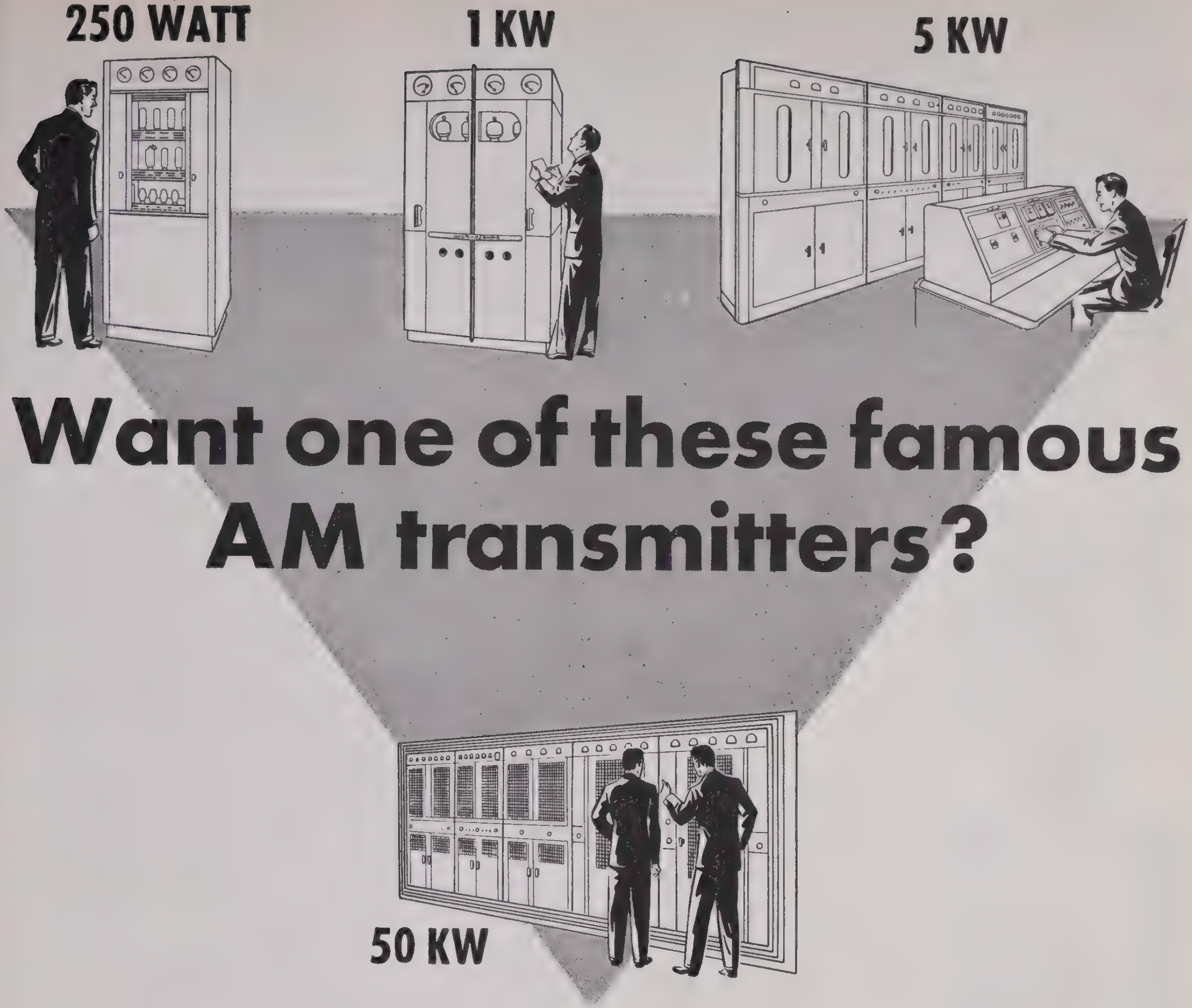
"Magnetrons, Their Development and Production," by R. R. Hancox, Midwest Research Institute; October 21, 1947.

"Point-to-Point Radio in the Bell System," by H. I. Romnes, American Telephone and Telegraph Company; December 4, 1947.

LONDON (CANADA)

"Determining Fxctors in Microwave Antennae," by G. A. Woonton, University of Western Ontario; December 5, 1947.

(Continued on page 36A)



Want one of these famous AM transmitters?

You can get it... *pronto!*...from stock

We're all caught up on back orders for these popular AM transmitters. So you can order yours today with assurance that *you'll get it as soon as you want it!*

The 1 KW, 5 KW and 50 KW all have the famous Doherty *High Efficiency* Amplifier Circuit that has saved untold thousands of operating dollars for broadcasters.

For details about the quality, dependability and economy that have made these Western Electric AM transmitters so popular in so many stations—and for information on the complete line of audio facilities and accessory antenna equipment—call your Graybar Broadcast Representative. Or write to Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y.

Western Electric

— QUALITY COUNTS —

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OFFICES IN 93 PRINCIPAL CITIES

DISTRIBUTORS: IN THE U. S. A. — Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Company, Ltd.

New SHURE
Wire Recording Heads

. . . offer unusual versatility of mechanical and electrical adaptation

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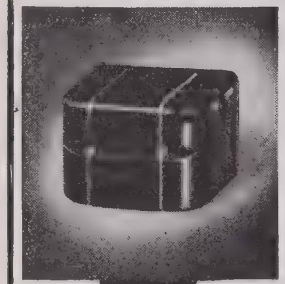
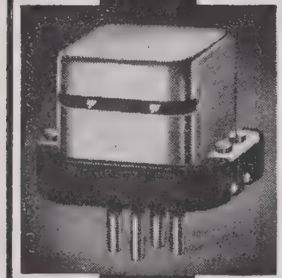

WR 16


WR 12

WR 14

CHECK THESE FEATURES FOR EXCEPTIONAL PERFORMANCE

1 Versatility of playback and recording circuits.

2 Variety of Impedances for individual needs.

3 Closely controlled Air-Gaps for uniform performance.

4 Reduction of hum pickup.

5 Controlled groove contour for maximum effective position of recording wire.

6 Excellent wear characteristics.

Shure Patents Pending

SHURE

MORE COMPLETE INFORMATION IS AVAILABLE TO FIRMS INTERESTED IN THE MANUFACTURING OF WIRE RECORDING EQUIPMENT. WRITE ON COMPANY LETTERHEAD.

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Microphones & Acoustic Devices
225 W. HURON ST., CHICAGO 10, ILL. • CABLE ADDRESS: SHUREMICRO

SECTION MEETINGS

(Continued from page 34A)

Los Angeles

"Train Communication by F.M. at 161 Mc.," by W. U. Dent, Westinghouse Electric Corporation; December 16, 1947.

"Patent Procedure for Engineers," by R. C. Lawlor, Patent Agent; December 16, 1947.

Louisville

"The Clear Channel Broadcasting Service's 20-Station Plan for Nationwide Broadcast Coverage," by O. W. Towner, Station WHAS; October 20, 1947.

"Radar on the River," by B. B. Talley, United States Army; December 12, 1947.

Montreal

"A Symposium by C. B. C. Engineers on Problems Which Have Been Investigated in their Transmission and Development Department," by J. E. Hayes, H. W. McCrae, R. E. Santo, and D. H. Bastin; December 10, 1947.

New York

"New York-Boston Radio-Relay System," by G. N. Thayer, Bell Telephone Laboratories; December 3, 1947.

Ottawa (Canada)

"Aurora and Skywave Radio," by F. T. Davies, Defence Research; December 11, 1947.

Philadelphia

"The Institute of Radio Engineers," by W. R. G. Baker, Past President of The Institute of Radio Engineers; December 4, 1947.

Portland

"The Acoustic System in the Brain as Studied in Animals; its Relation to the Physics of Sound as Applied to Human Hearing," by A. Tunturi, University of Oregon Medical School; November 25, 1947.

"The Portland Urban Mobile Telephone System," by R. Scott, The Pacific Telephone and Telegraph Company; December 18, 1947.

Election of Officers; December 18, 1947.

Sacramento

"Ground Controlled Approach," by T. J. Tipton, Gilfillan Brothers; November 25, 1947.

"Indicating Instruments," by L. F. Parachini, Western Electrical Instrument Corporation; December 9, 1947.

St. Louis

"Operating Aspects of Television," by W. L. Lawrence, RCA; December 17, 1947.

Seattle

"Impedance Measurements at U.H.F. Frequencies," by R. A. Soderman, General Radio Company; September 12, 1947.

"A 5-Kw. Television Transmitter," by J. E. Keister, General Electric Company; September 29, 1947.

"Electrical Circuits to Perform Mathematical Operations," by A. R. Jacobsen, University of Washington; November 21, 1947.

Syracuse

"Telemetry System for Guided Missiles," by W. Hausz, General Electric Company; December 4, 1947.

Toronto

"Problems in the Design of F.M. Receivers," by E. C. Freeland, Philco Corporation; November 10, 1947.

"Problems in Establishing a Television Service," by W. R. Ahern, General Electric Company; December 8, 1947.

(Continued on page 38A)

UNITED
United

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First Choice
OF THE
MAIN LINE
AIRWAY

UNITED AIR LINES Selects New WILCOX VHF Receiver For Ground Installations

New Fixed Frequency Receiver Offers New Performance Features in the 118-136 Mc. Band

- Selectivity Permits 100 Kc. Adjacent Channel Operation
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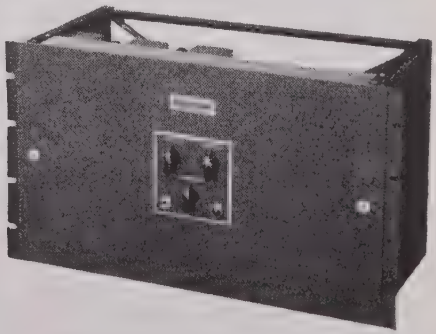
- New Noise Limiter Means Better Reception
- Single Unit Construction Saves Space



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THE NAME
WILCOX MEANS *Dependable Communication*

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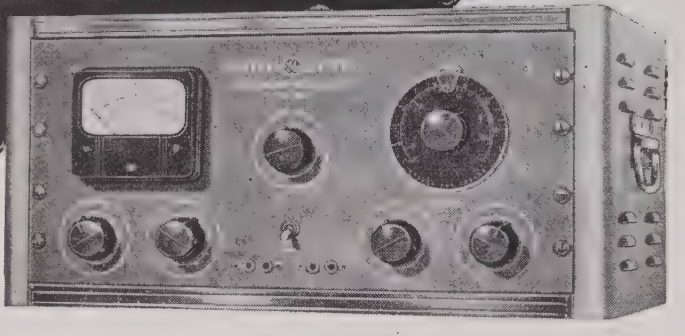
DISTORTION AND NOISE ANALYZER

TYPE YDA-1



THIS new General Electric distortion and noise analyzer gives a convenient check on transmitter operation. It provides a quick, visible indication that your station is operating in accordance with required standards. The YDA-1 is also entirely suitable for use with the widely accepted FM and AM General Electric Broadcast Station Monitors.

The YDA-1 accurately measures total harmonic distortion and noise present on an audio frequency, particularly that present in laboratory and broadcasting equipment.

The unit may also be used as a sensitive voltmeter. Its sensitivity is of special advantage in measuring low level audio signals.

DISTORTION MEASUREMENTS:

Distortion range:	1, 3, 10, 30 and 100% full scale
Frequency range:	50 to 15,000 cycles per second in 5 ranges
Accuracy:	5% of full scale plus 1/10% distortion

NOISE MEASUREMENTS:

Noise range:	+2 to -80 db referred to 1 milliwatt on 600 ohms
Frequency range:	30 to 30,000 cycles per second
Accuracy:	5% of full scale

VOLTAGE MEASUREMENTS:

Vacuum tube voltmeter for general purpose measurements. Dial is calibrated from +2 to -80 db referred to 1 milliwatt on 600 ohms.

For complete information on the YDA-1, and other precision equipments write: *General Electric Company, Electronics Department, Electronics Park, Syracuse, New York.*

165-G1

GENERAL ELECTRIC

SECTION MEETINGS

(Continued from page 36A)

TWIN CITIES

"Thermal Control of Cavity Tuning," by W. G. Shepherd, University of Minnesota; November 24, 1947.

"Air Navigational Systems," by F. L. Mosely, Collins Radio Company; December 10, 1947.

WASHINGTON

"Effects of the Recent Solar Total Eclipse on the Ionosphere," by A. H. Shapley and J. M. Watts, National Bureau of Standards; December 8, 1947.

Election of Officers; December 8, 1947.

SUB-SECTIONS

AKRON

"Stereoscopic Viewing of Oscillograms and Radar Presentations," by R. L. Burtner, Goodyear Aircraft Corporation; October 21, 1947.

"Beam Deflection Mixer Tubes for Ultra-High Frequencies," by E. W. Herrold, RCA Laboratories; November 17, 1947.

HAMILTON

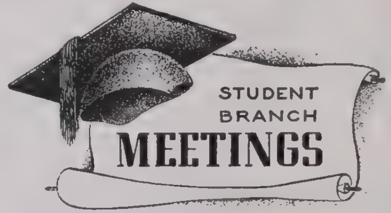
"Provincewide F.M. Communications," by W. J. Ward, Canadian General Electric Company; December 1, 1947.

LANCASTER

"A Report on the International Radio Congress in Rome," by I. E. Mouromtseff, Upsala College; December 10, 1947.

LONG ISLAND

"Infrared Vision by the Image Tube," by G Krieger, RCA Laboratories; October 29, 1947.



STUDENT BRANCH MEETINGS

UNIVERSITY OF ILLINOIS, I.R.E.—A.I.E.E. BRANCH

"Membership Drive," by W. L. Everitt, University of Illinois; October 23, 1947.

"Mobile Radio Transmission," by O'Conner, Illinois Bell Telephone Company; November 13, 1947.

"Power Transmission," by A. R. Slinger, General Electric Company; December 11, 1947.

KANSAS STATE COLLEGE, I.R.E. BRANCH

"The Kansas State College Television Project," by K. H. Martin, Kansas State College; December 4, 1947.

UNIVERSITY OF MICHIGAN, I.R.E.—A.I.E.E. BRANCH

"Television at WWJ-TV," by Leonard Spragg, Radio Station WWJ; November 12, 1947.

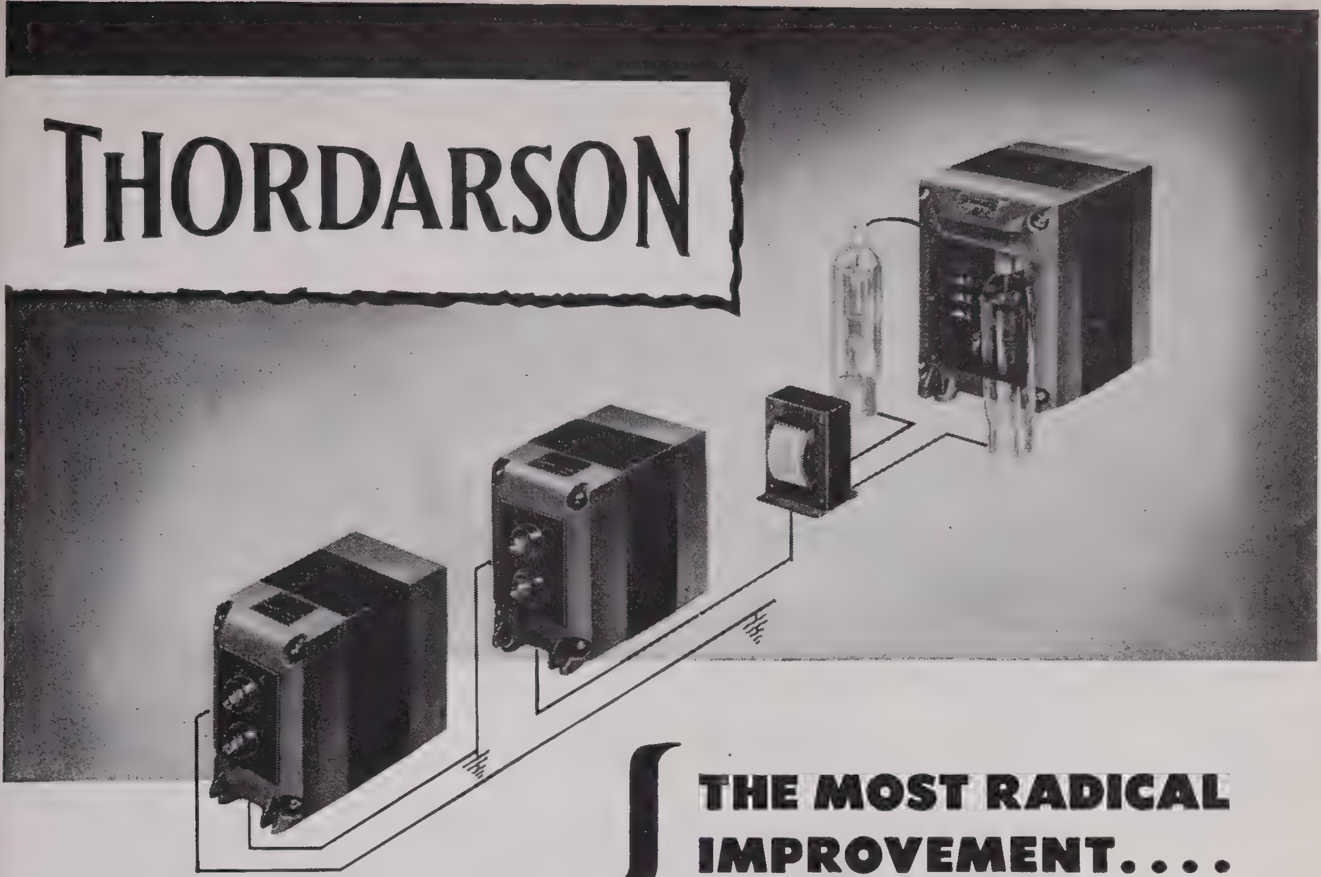
"Integrated Engineering," by Waidelich, The Austin Company; November 18, 1947.

Field Trip to WWJ-TV, November 19, 1947.

"Industrial Applications of Photo Cells," by L. L. Worner, Worner Electronic Appliances; December 9, 1947.

(Continued on page 40A)

THORDARSON

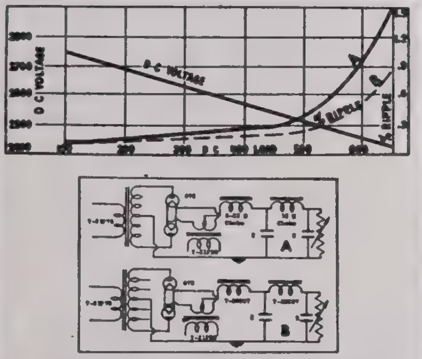


THE MOST RADICAL IMPROVEMENT.... IN POWER SUPPLY FILTER CIRCUITS...

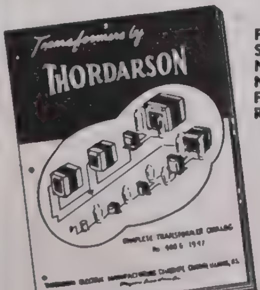
. . . employing two same type universal chokes that provide more efficient filtering.

Here again, is another triumph in Thordarson engineering skill. Thordarson engineers have developed a new universal type choke in sizes to meet all power requirements! This achievement offers the best possible filtering and regulation in a minimum size consistent with conservative design! One reactor may be used in a single section filter with all the advantages of the radically swinging type. Two similar units may be employed in a two section filter more satisfactorily than the obsolete "swinging and smoothing" system, and deliver far better performance.

Let us know how we can put these new universal chokes to work for you . . . Send us your requirements.



Actual Laboratory Measurements Made With The Conventional Type Filter Circuit A — (Swinging and Smoothing System) — and with the New Universal Choke Filter Circuit B Show A Decrease In Ripple Throughout The Useful Current Range of Power Supply



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GROOMING an ADC TRANSFORMER for FAULTLESS PERFORMANCE

3 Complete Tests to Meet Rigid ADC Specifications

Strict electrical tests are given to **ADC** Transformers at three different stages of production. In order to give you faultless performance on the job, each and every transformer must come within **ADC** catalog specifications on every test. (Customer specifications on special transformers.)

1st TEST. After assembly of coil and laminations, each component is given complete performance tests for compliance with specifications. *Any* unit failing to meet *all* requirements is rejected.

2nd TEST. After impregnation, baking and casing, each transformer is re-checked for continuity, breakdown and other requirements of the particular unit. This guarantees correct wiring, perfect insulation—no "shorts" or "opens."

3rd TEST. After cleaning, labeling, etc., a final continuity, breakdown and thorough visual check is made. This quality control test—plus the finest materials and workmanship available—assures you of faultless performance on the job.

ADC Quality

ELIMINATES necessity for large over-runs to allow for rejects. (Customer returns consistently less than ½ of 1%.)

AVOIDS expense and delays due to rejects which must be sent back.

GUARANTEES performance as specified in **ADC** catalog. (Custom-built transformers guaranteed to meet *your* specifications.)

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"Audio Develops the Finest"

Audio Development Co.
2833-13th Avenue So., Minneapolis, Minn.

STUDENT BRANCH MEETINGS

(Continued from page 38A)

University of Minnesota, I.R.E.—A.I.E.E. Branch

Business Meeting, November 13, 1947.

Inspection Trip Through the High Bridge Generating Plant; November 18, 1947.

The College of the City of New York, I.R.E. Branch

"Microwaves," by Samuel Freedman, De-Mornay-Budd, Inc.; November 25, 1947.

"Problems of Frequency Modulation," by H. A. French, Federal Telecommunications Laboratories; December 2, 1947.

"Power Measurements of Class-B Audio Amplifiers," by D. P. Heacock, Radio Corporation of America; December 9, 1947.

"Organization of Electronic Research," by R. M. Bowie, Sylvania Electronic Products Company, Inc., December 11, 1947.

New York University (Day Division), I.R.E. Branch

"A Preview of the Graduate Engineer in Industry," by Heins, Westinghouse Electric Corporation; November 17, 1947.

North Carolina State College, I.R.E. Branch

"Peacetime Applications of Radar," by F. E. Burley, Western Electric Company; December 3, 1947.

Northwestern University, I.R.E.—A.I.E.E. Branch

Business Meeting; October 23, 1947.

"Directional Patterns of Broadcast Radio Antennas," by F. E. Butterfield, Andrew Corporation of Chicago; November 7, 1947.

"Professional Engineering Today," by George C. Lamb, Northwestern University; November 20, 1947.

"The Selection and Use of Electrical Measuring Instruments," by Ernest O. Martin, Westinghouse Instrument Section; November 20, 1947.

Pratt Institute, I.R.E. Branch

"Topics in Modern Physics," by Dov Abramovich, Secretary; December 3, 1947.

Stanford University, I.R.E.—A.I.E.E. Branch

"Inspection of Ground-Control Approach System at Moffett Field," by Fred Kruse; November 14, 1947.

"Telemetering and Electronic Instrumentation in the V-2," by John R. Kauke, Naval Research Laboratory; November 19, 1947.

"Behind the Instrument Dial," by Lawrence F. Parachini, Weston Electrical Instrument Corporation; December 3, 1947.

University of Texas, I.R.E.—A.I.E.E. Branch

"New Targets for Radar," by A. W. Straton, University of Texas; November 10, 1947.

"Should Engineers be Licensed," by W. R. Woolrich, A.S.E.E.; J. S. Hudnall, A.I.M.M.E.; M. J. Thompson, I.E.E.; Tugg Twichell, T.S.P.E.; J. P. Exum, A.S.M.E.; B. N. Gafford, A.I.E.E.; Percy Pennybacker, A.I.E.E.; Carl Ledbetter, A.I.E.E.; Carl Swenson, A.S.M.E.; W. A. Cunningham, A.I.Ch.E.; November 24, 1947.

"The Engineer After Graduation," by C. R. Granberry, University of Texas; December 8, 1947.

(Continued on page 42A)

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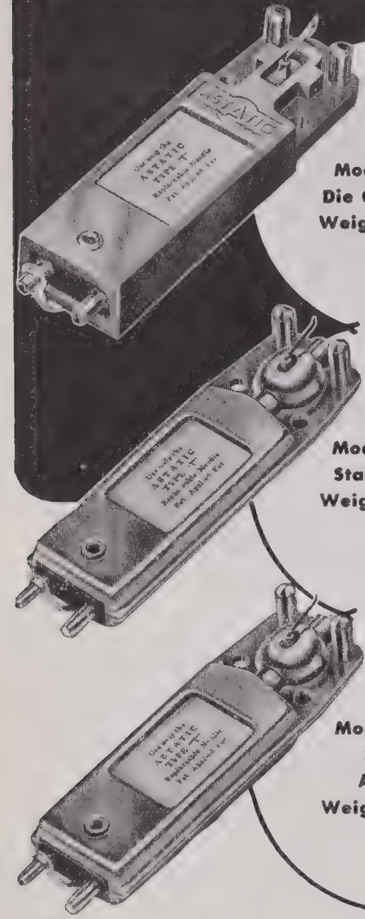

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(Continued from page 40A)

University of Utah, I.R.E.—A.I.E.E. Branch

"Education in India," by M. A. Haque, Student; December 9, 1947.

Worcester Polytechnic Institute, I.R.E.—A.I.E.E. Branch

"Electronics in Aerial Reconnaissance," by Dr. Gunter, Clark University; November 25, 1947.

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Crawford, R. V., 10 Manor Pl., Dobbs Ferry, N. Y.
Eberhart, E. K., Bell Telephone Laboratories, Inc., 180 Varick St., New York 14, N. Y.
Elmendorf, C. H., III, 463 West St., New York 14, N. Y.
Embrechts, A. C., 91 Marion Ave., Staten Island 4, N. Y.
Gunther, C. A., RCA Victor Division, Bldg. 10-7, Camden, N. J.
Kelterborn, W. H., Canadian Westinghouse Co., Aberdeen Ave., Hamilton, Ont., Canada
Libscomb, E. W., 4433 Stanford St., Dallas 5, Tex.
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Miller, C. F., National Union Research Department, 350 Scotland Rd., Orange, N. J.
Mumma, R. E., 2000 Park Pl., Dayton 6, Ohio
Spaulding, F. E., Jr., 49 Grant Ave., White Plains, N. Y.
Straube, H. M., 463 West St., New York 14, N. Y.
Umpleby, K. F., Research Department, Bendix Radio, Baltimore 4, Md.
Walker, F. R., 710 Williamson Building, Cleveland 14, Ohio
Wild, R. F., 331 Wellesley Rd., Philadelphia 19, Pa.

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Newman, R. J., 1007 Maryland Ave., Schenectady, N. Y.
Tucker, R. S., Bell Telephone Laboratories, Inc., 463 West St., New York 14, N. Y.

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Carroll, C. T., 4401 W. Fifth Ave., Chicago 26, Ill
Ehrman, E. F., Box 22, High, Iowa
Fich, S., College of Engineering, Rutgers University, New Brunswick, N. J.
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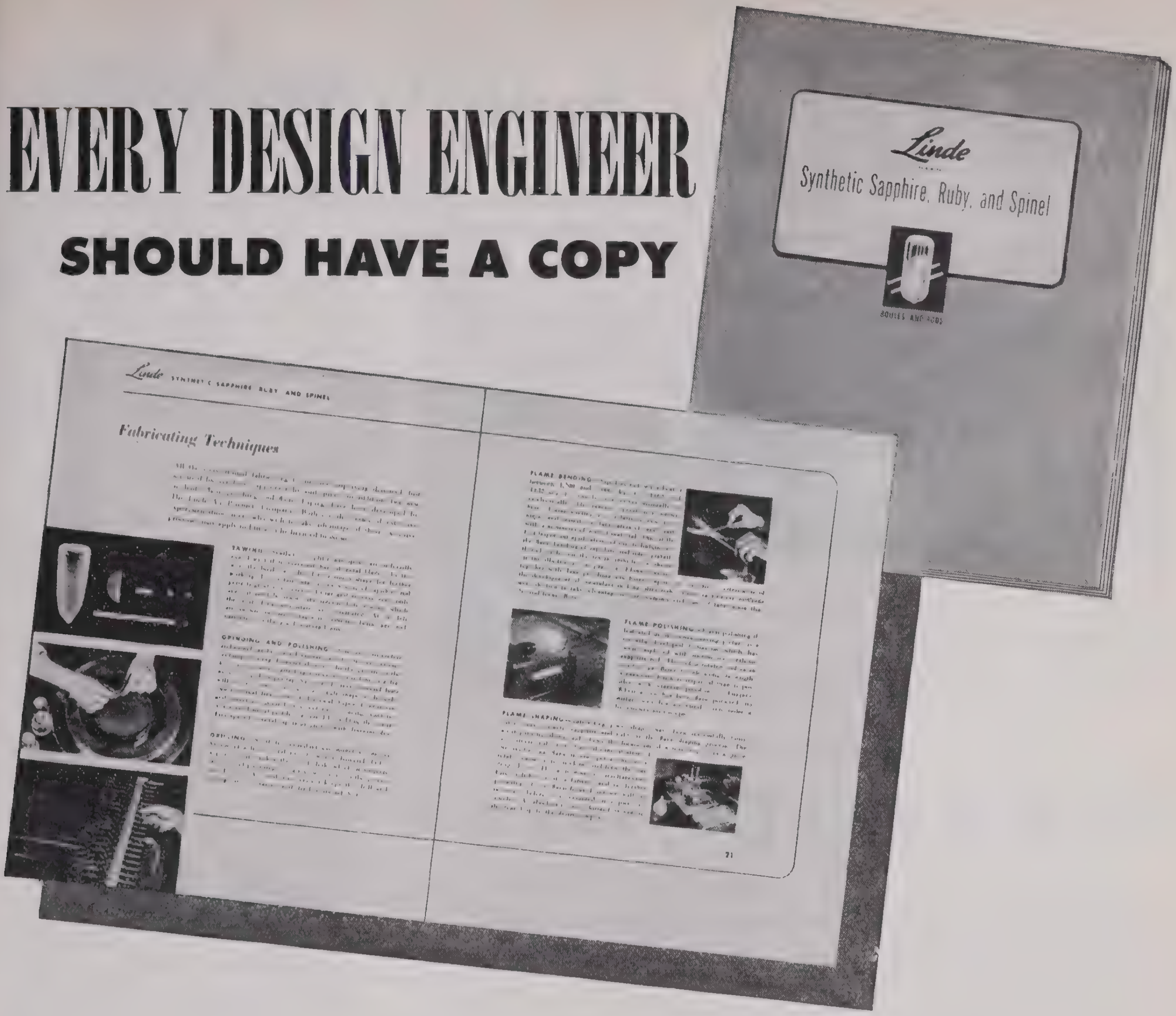

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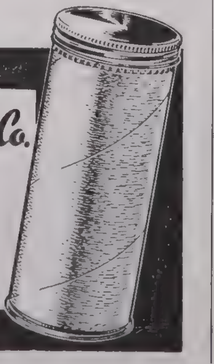

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Johnson, C. K., 4736 Oak, Kansas City 2, Mo.
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Shuler, M. H., 2120 Scott Ave., Los Angeles 26, Calif.
Slavin, S., 427 Scott St., San Francisco 17, Calif.

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Callais, R. T., 381 Bergen St., Brooklyn, N. Y.
Campbell, J. H., Engineering Division, General Electric Co.
Nela-Park, Cleveland 12, Ohio
Chernin, M. G., 15 Juniper Ave., Mineola, L. I., N. Y.
Cobb, L. J., Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Costrell, L., 939 Longfellow St., N.W., Washington 11, D. C.
Foote, H. L., Stromberg-Carlson Co., 100 Carlson Rd., Rochester 3, N. Y.
Gershater, S. H., 937 Cullom Ave., Chicago 13, Ill.
Glassman, I., 308 S. 13 St., Philadelphia, Pa.
Holdredge, R. F., 2810 N. 72 St., Milwaukee 10, Wis.
Loofbourrow, R. J., Box 422, Bellaire, Tex.
Northrop, B. K., Franklin Hall, Cornell University, Ithaca, N. Y.
Orr, J. B., 4459 Cape May Ave., San Diego 7, Calif.
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Sturgeon, W. S., 45-27—256 St., Great Neck, L. I., N. Y.
Sullivan, A. H., Jr., 408 Melrose Ave., Southern Hills, Dayton, Ohio
Thomas, H. C., 130 Billings St., N. Quincy 71, Mass.
Ward, A. E., 88 Radcliffe St., Dorchester 21, Mass.
Wolf, H. K., 869 Center, San Luis Obispo, Calif.

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Apte, R. M., c/o Air India, Ltd., Radio Department, Santacruz East, Bombay, India
Arman, A. J., 1101 N. Christiana Ave., Chicago 51, Ill.
Arveschoug, N. F., 463 Main St., Metuchen, N. J.
Bakst, A. A., 2431 Tusitala St., Honolulu, T. H.
Baumgarte, P. H., 410-B—12 Lane, Brooklyn 12, N. Y.
Beers, R. B., 5913 Rambo Lane, Toledo 12, Ohio
Betts, R. I., Star Route, Altamont, N. Y.
Bialy, A. S., 180 S. Sierra Madre Blvd., Pasadena 10, Calif.
Bodge, A. H., Audio Devices, Inc., 844 Seward St., Hollywood 38, Calif.
Boese, M. T., 3425 Mt. Pleasant St., Washington 10, D. C.
Burnell, J. D., "Florence Lodge," Main Rd., Claremont, Cape Town, South Africa

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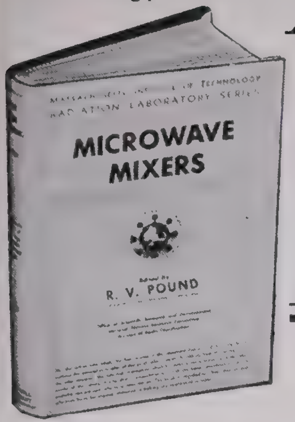
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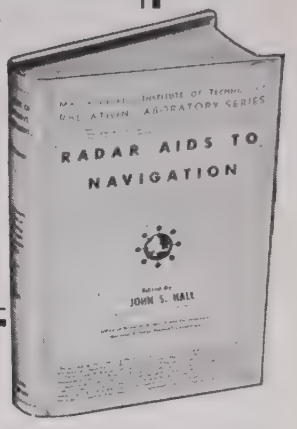
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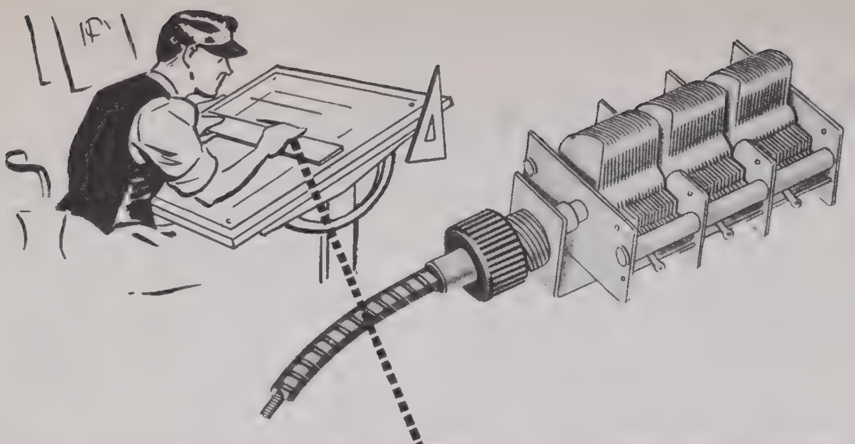

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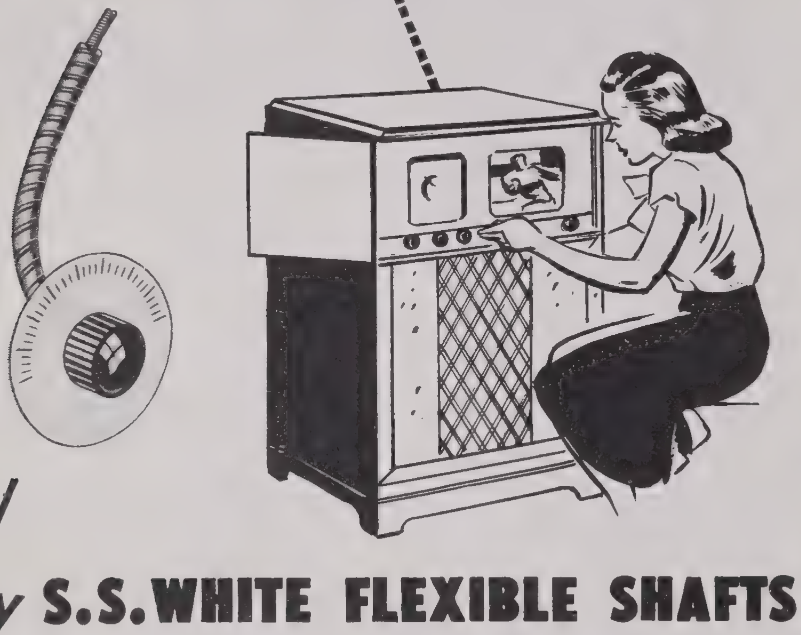

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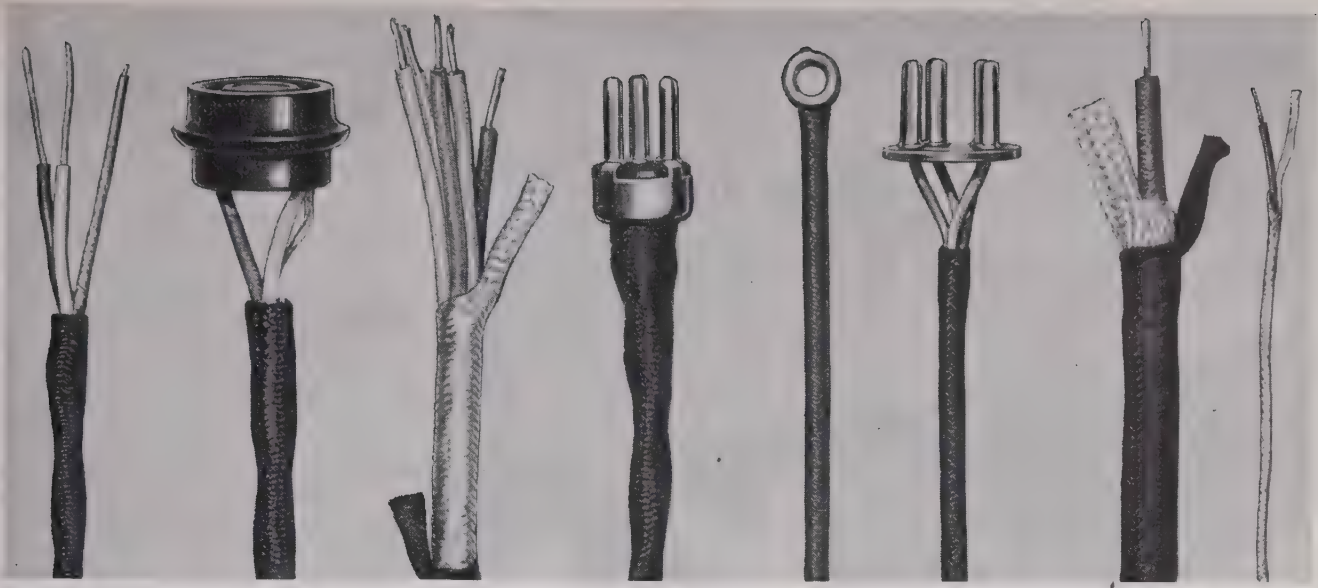

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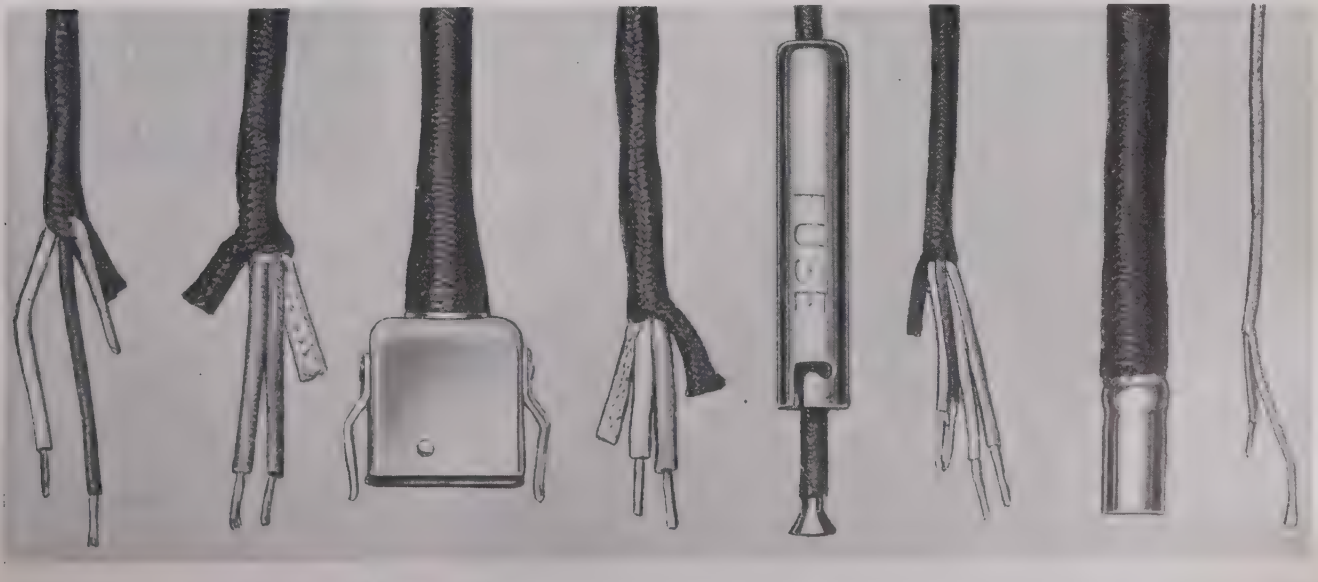

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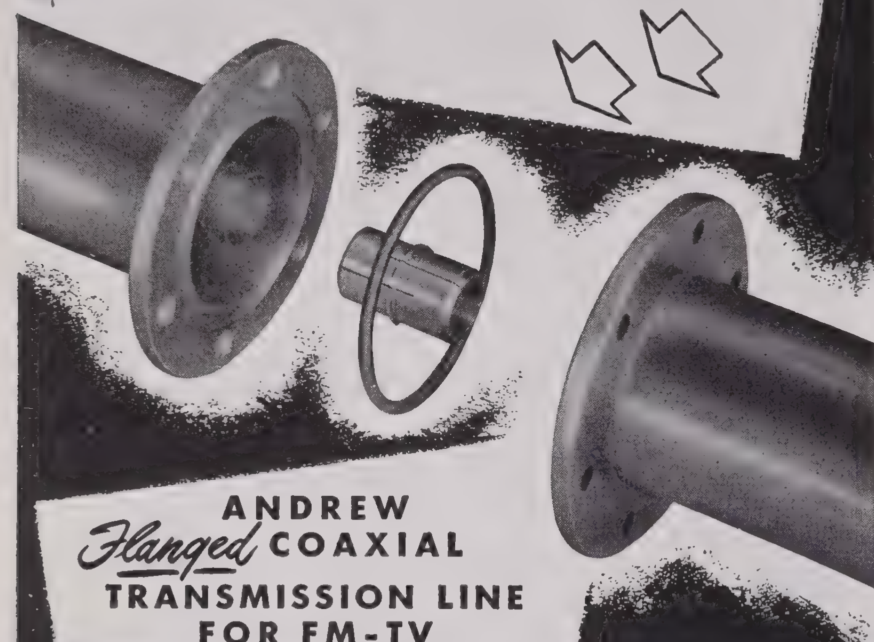


ANDREW
Flanged COAXIAL
TRANSMISSION LINE
FOR FM-TV

ANDREW

Offering the dual advantage of easy, solderless assembly and a constant impedance of 51.5 ohms, this new ANDREW FM-TV line is available in four diameters. Each line fully meets official RMA standards. It also is recommended for AM installations of 5 Kw or over.

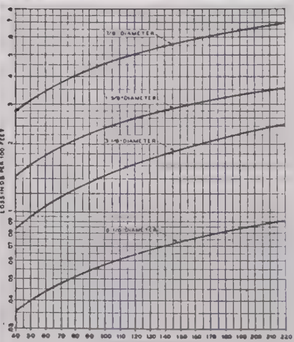
Fabricated in twenty foot lengths with brass connector flanges silver brazed to the ends, sections are easily bolted together. A circular synthetic rubber "O" gasket effectively seals the line. Flux corrosion and pressure leaks are avoided. A bullet-shaped device positively connects inner conductors.

Close tolerances are maintained on characteristic impedance in both line and fittings, assuring an essentially "flat" transmission line system.

Mechanically and electrically better than previous types, this new line has steatite insulators of exceptionally low loss factor. Both inner and outer conductors of all four sizes are of copper having very high conductivity.

Flanged 45 and 90 degree elbow sections, and a complete line of accessories and fittings available.

Better be safe, than sorry. Avoid costly post-installation line changes. Get complete technical data, and engineering advice, from ANDREW now.



ATTENUATION CURVE

shows total loss plus 10% derating factor to allow for resistance of joints and deterioration with time.

Four diameters available: 6⅛"—3⅛"—1⅝" and ⅞".

Andrew
CORPORATION
363 EAST 75th STREET · CHICAGO 19

Pioneer Specialists in the Manufacture of a Complete Line of Antenna Equipment

MEMBERSHIP

(Continued from page 46A)

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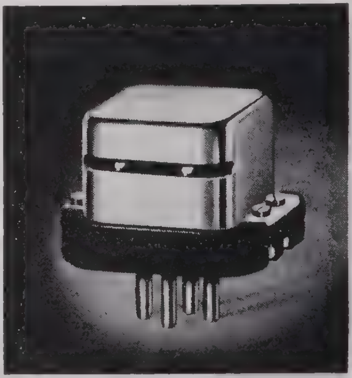
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Wire-Recording Heads



This illustration shows Model WR-12 of a new line of wire-recording heads being produced by **Shure Brothers, Inc.,** 225 West Huron St., Chicago 10, Ill. The manufacturer states that the new heads are unusual in the versatility of their mechanical and electrical adaptations. Recording, playback, and erasing features have been combined into one small compact unit. Mechanical construction also permits a variety of shielding and mounting arrangements. Impedances and internal connections may be varied to suit individual needs. All information requests should be sent to the manufacturer on company letterheads.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Versatile Cathode-Ray Oscillograph

Although initially developed as a precision ranging unit for radar installations, the new DuMont Type 256-D cathode-ray oscillograph presents special features making its use suitable for various industrial and research applications. It has been released by **Allen B. DuMont Laboratories, Inc.,** 100 Main Ave., Clifton, N. J.

The variety of sweep lengths, the accurate delay circuits, the crystal-controlled markers, the variable internal trigger generator, and the wide-band video amplifier, all of which are featured in this instrument, make it a very versatile unit. According to the manufacturer, provision is made for calibrating its own sweep circuits, while its calibrating accuracy is assured by the locking of the trigger to the markers.

A Type 5CP-A cathode-ray tube is used as the indicator. The over-all accelrating potential applied to this tube is 4,000 volts, which, in conjunction with an auxiliary focus control, produces a clear, fine trace.

Two types of sweep are provided, namely: "A" sweep and "R" sweep. On the "A" type, sweep speeds of 4, 10, 25, 100, 1000, or 4500 μs. may be selected. On the "R" type, sweep speeds of 4, 10, or 25 μs. may be selected. Provision is made to observe any 4, 10, or 25 μs. portion of the 100 μs. "A" sweep or any 10 or 25 μs portion of the 1000 μs "A" sweep. When measuring on the "R" sweep, the sweep delay interval is adjustable to an accuracy of ±0.1 per cent of full scale of the sweep-delay range used.

This instrument weighs 104 pounds, and it is 11⅜ inches wide, 16¼ inches high, and 26 inches deep. Power requirements are 115 volts ±10 per cent, single phase, 60 cycles, 220 watts, usable to 1200 cycles.

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

(Continued on page 55A)

RADAR
AIRCRAFT

"Communications"

INDUSTRIAL
AMATEUR

DYNAMOTORS

PE 73 CM Power supply for BC 375. Input: 28 VDC. Output: 1000 VDC @ 350 Ma. Starting relay, filter, etc. (New) $4.95

Mfrs.: Write for quantity, prices & discounts on above item. BD 77, Power supply for BC 191. Input: 14 VDC. Output: 1000 VDC @ 350 Ma. New, with spare fuse links, etc. $5.95

PE 101C, Input: 13/ @ 12.6/6.3 A. Output: 400 VDC @ 135 Ma., 800 VDC @ 20 Ma. (9VAC @ 1.12 A.) $3.49

PE 86 N. Input: 28 VDC. Output: 250 VDC @ 60 Ma. Westinghouse w/Filter $1.95
Without Filter $1.60

PC 77, Input: 12 VDC, Output: 275 VDC @ 110 Ma. 500 VDC @ 50 Ma. $3.25

DAG 33 A, Input: 18 VDC @ 3.2 A, Output: 450 VDC @ 60 Ma. $2.45

DM 33A, Input: 28 VDC @ 7 A, Output: 540 VDC @ 250 Ma. Power supply for modulator of SCR 274 N. $3.95

Dyn. Model 23350. Input 27 VDC @ 1.75 A. Output: 285 VDC @ 75 Ma. $1.75

DM-21: In 14VDC 3.3A Out 235VDC 90 ma. with filter $2.59

PE 55. Input: 12 VDC @ 25 amp. Output: 500 VDC @ 400 ma. (slightly used) $4.95

MP 10 G Power supply, using 2 dynamotors Input: 24-28 VDC. Output: 1000 VDC @ 400 Ma. 230 VDC @ 100 Ma. New, complete with relays, filters, etc. BENDIX $20.00

B-19 power pack (dynamotor). Input: 12 VDC @ 9.4 amp. Output: 275 VDC @ 110 Ma. 500 VDC @ 50 Ma. New, complete in metal case with 2 plugs filter, etc. $4.75

INVERTERS

PE 206-A. Input: 28 VDC @ 38 amp. Output: 80 volts @ 500 volt-amp, 800 cy. Leland Electric. New, complete with instruction book, relays, filters, etc. $12.50

PE 218-Input: 25-28 VDC @ 92 amp. Output: 115 volts, 1500 volt-amps, 380/500 cy. Leland Electric $15.00

MICROWAVE TEST EQUIPMENT

Wave guide experimental kit. Consists of: One direct-reading wavemeter, app. 2600-3400 mc. (cavity type); One dummy load w/crystal probe. One line stretcher full wave; two wave guide to RG 18/U coax couplers: two 1′ sections w/flanges complete $250.00

10 CM ECHO BOX, complete with micrometer adjust cavity & resonance indicator. Type TS 238/GP. With calibration chart $105.00

W.E. 1138 A. Signal generator, 2700-2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input. reg. Pwr. supply. With circuit diagram $50.00

MICROWAVE TUBES

(Magnetrons)

2J32	$15.00	2J21	$15.00
Magnet for 2J32	$ 8.00	2J21A	$15.00
2J38 with magnet	$25.00	2J22	$15.00
2J55 with magnet	$25.00	2J26	$15.00
3J31	$17.50	2J27	$15.00
Magnet for 3J31	$ 8.00	2J31	$15.00

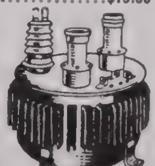
W.E. 700A (L band) $45.00
W.E. 720BY (S Band) 1000 Kw. $25.00
Klystron—2K25-723-AB $3.50

PULSE TRANSFORMERS

GE $ K 2731

Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. PWR Out: 800 KW. Bifilar: 2.75 Amp. $19.50

All Standard name items



Type G.E. K2450A Will receive 13KV, 4 micro-second pulse on pri., secondary delivers 14KV Peak power out 100KW GE $15.00

HI Volt. Magnetron Input transformer W.E. $ D-166173 with cooling fins $12.00

UX 4298E Raytheon Pri. 4 KV. 1 microsecond Sec. 16 KV. 1* amps. Fil pri. 115 v. 400 Cycle. Raltheon $15.00

HI Volt input pulse Transformer W.E. $ D169271 .... 9.95

Pulse Input, line to magnetron. G.E. K2748A 12.00

Utah Pulse or Blocking Oscillator Transformer Freq limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛ x 19/32 .... .75

MICROWAVE ANTENNAS

3 CM. ANTENNA WITH DISH 14½". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. Complete. New. $65.00

Relay System Parabolic reflectors approx. range: 2000 to 6000 Mc. Dimensions 4. -5′ x 3′ New .$85.00

Dipole for above $5.00

TDY "Jam" Radar rotating antenna, 10cm. 30 deg. beam. 115V AC drive. New $100.00

SO Surface Search Radar rotating antenna, 10cm. 24" dish. complete with drive and selsyn motors. New $75.00
Used $45.00

10 Cm Horn, rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange $35.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes ..$20.00

Cone Antenna, AS 125 APR, 1000-3200 mc. Stub supported, with type "N" connector $4.50

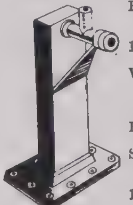
140-600 Mc DIRECTIONAL ANTENNA

140-310 Mc cone and 300-600 Mc cone, each consisting of 2 end fed half wave conical section with enclosed matching stub for reactance changes with changing frequency. New, complete with mast, guys, cables, hand portable carrying chest $49.50

AN/TPS-3 Parabolic reflector, approx. 10 ft. diam. Extremely lightweight construction. New, in portable carrying case $35.00

MICROWAVE PLUMBING

10 CENTIMETER



Sand Load (Dummy Antenna) wave guide section with cooling fins, app. 23" high	$28.00
Rigid Coax Directional Coupler CU-90/UP 20 DB drop, has short right angle, about 8"	5.50
Flexible Coaxial Connector, rigid coax to rigid coax ⅞" diam.	2.50
10 CM Dipole and Reflector with type "N" Fitting	2.75
Waveguide to flexible coax coupler (RG 18 U), with flange. Gold plated. App 10" high (as shown)	17.50
Rigid coax slotted section CU-60/AP	5.00
Stub-supported rigid coax, gold plated, 5′ lengths. Per 5′ length	5.00
10 Cm. McNally cavity. Silver Plated. Type SG	3.00 Ea.
Crystal Mixer, "S" Band. Complete with Type "N" fitting and 1N22 crystal	3.85
10 Cm waveguide, 5′9" choke to cover Per section	12.00
Per set of 4 sections	45.00
⅞" coax, rotary joint	8.00
Magnetron coupling to ⅞" rigid coax	4.00
⅞" rigid coax. Rt. angle bend 15" long overall	2.00

3 CENTIMETER

Pick-up loop with adjustable tuning section, used in duplexer cavity	1.50
Thermistor mount in wave guide with tunable terminations	8.00
Tuner/attenuator, W.E. guide, gold plates	3.75
TR/ATR section with wavemeter iris flange	4.00
CG/APS-3, waveguide section. 10" choke to cover	1.75
Right angle elbow, 5½" choke to cover, 2½" radius. E plane	4.50
H plane	5.50
Twist. 90 deg. 6" choke to cover	5.00
Wave Guide Sections 2.5′ long, silver plated with choke flange	$5.75
Wave Guide 90 deg. bend E Plane 18" long	4.00
Wave Guide 90 deg. bend E plane with 20DB directional coupler	4.75
Wave Guide 18" long "S" curve	2.00
Rotary Joint choke to choke	6.00
Rotary Joint choke input; round guide output	5.25
S-Curve Wave Guide 8" long cover to choke	2.50
Duplexer Section using 1B24	10.00
Wave Guide 5′ length per foot	1.50
3 Cm Wavemeter Maquire 1528TFX-24GA	15.00
3 Cm stabilizer cavity, turnable transmission type. Model 1551 (TFX 11 GA)	20.00
3 Cm waveguide, 1⅛" x ⅛" 15 Ft. lengths available Per Ft.	1.50

1.25 CENTIMETER

Wave Guide Section 1" cover to cover	$2.00
T Section choke to cover	4.50
Mitred Elbow cover to cover	3.00
Mitred Elbow and "S" sections choke to cover	8.50
Flexible Section 1" long choke to choke	3.00

CONNECTORS

UG 21/U. Type "N", Male	$ .85
UG 86/U. Gold Plated	.95

All merchandise guaranteed. Mail orders promptly filled. All prices, F.O.B. New York City. Send Money Order or Check. Shipping charges sent C.O.D.

COMMUNICATIONS EQUIPMENT CO.
131-R Liberty St., New York City 7, N.Y. (Mr. Rosen) Digby 9-4124

ENGINEERS

The Crosley Division, AVCO Manufacturing Corporation is rapidly expanding its television department and has excellent openings for a few qualified engineers and technicians. Modern laboratory and other engineering facilities provide ideal working conditions. Forty-hour week, insurance and hospitalization plan, and pension plan. Opportunities unlimited. Salary based on experience and ability.

***ENGINEER, SENIOR*—College graduate. At least two years' experience in product development of television receivers. Thorough knowledge of circuit design and analysis.**

***ENGINEER, SENIOR*—College graduate. At least four years' experience in high frequency circuit development. Experience in television, R.F. circuits and frequency modulation desirable.**

***ENGINEER, JUNIOR*—College graduate with experience in product development of television and radio receivers. Experience in the development or maintenance of radar or similar equipment helpful.**

***TECHNICIAN, SENIOR*—College degree or equivalent. Some experience in high frequency circuits, particularly television R.F. circuits. Be familiar with test procedures. Will train to a limited degree.**

In replying give age, experience, education, and salary requirements, addressing replies to Crosley Division, AVCO Manufacturing Corporation, 1329 Arlington Street, Cincinnati 25, Ohio, attention Director of Research and Engineering.

Experienced Senior Engineers Electronic Missile Control

Navy project for Guidance and Control of Missiles requires Senior Engineers for responsible positions in analysis, development and test of radar equipment, electro-mechanical servo-mechanisms, electronic timing and control circuits, and other associated equipment. Bachelor's Degree in Electrical Engineering or Physics required, with Master's Degree or equivalent study of Mathematics, Electronics and Applied Physics desirable. Salary to $7500.00 depending upon qualifications.

Write or phone Mr. C. D. Perrine, Jr., Chief Electronics Engineer

Pilotless Plane Division

FAIRCHILD ENGINE AND AIRPLANE CORPORATION
FARMINGDALE LONG ISLAND
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WANTED PHYSICISTS ENGINEERS

Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or *development experience on radio communications systems, electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.*

WRITE FULL DETAILS
TO
EMPLOYMENT SECTION

SPERRY GYROSCOPE
COMPANY, INC.
Marcus Ave. & Lakeville Rd.
Lake Success, L.I.

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. . . .

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

ELECTRONIC ENGINEERS

Unusual opportunities for senior engineers experienced in recording sound on film and magnetic tape recording; microwave-antennae, wave guides, mixers, cavity resonators; receiver engineer-design experience in broad band receivers. Radar preferred. Two or three years experience in U.H.F. work. Outstanding opportunity for top flight men with a small aggressive company. Write Melpar, Inc. Employment Section, 452 Swann Ave., Alexandria, Virginia.

ENGINEER OR PHYSICIST

Engineer or physicist for mathematical research work on vacuum tubes. Should have a good knowledge of microwave tubes and electron optics. Apply Director of Research, 350 Scotland Road, Orange, new Jersey. National Union Radio Corporation.

SCIENTISTS AND ENGINEERS

Wanted for research and advanced development work in the fields of microwaves, radar circuits, gyroscope systems and general electronics. Scientific or engineering degrees required. Salary commensurate with experience and ability. Inquiries should be directed to Mgr. Engineering Personnel, Bell Aircraft Corp., Buffalo 5, N.Y.

JUNIOR ENGINEER—Editor and Writer

Excellent opportunity for experienced writer in radio and electronic fields to edit technical publication and handle articles for electronic, broadcast, aviation and amateur radio press. Congenial surroundings in attractive midwestern city. Please give full praticulars as to background, experience, age and salary in first letter. Collins Radio Company, Cedar Rapids, Iowa.

ENGINEERS AND PHYSICISTS

Several openings available in radar and in medium and ultra high frequency design work. Positions are in an Engineering Department of a progressive middle western manufacturer. Physicists will find unusual opportunities in the Research Department. A degree from a recognized engineering college is essential as well as good industrial experience. Address reply to Collins Radio Company, Cedar Rapids, Iowa.

ELECTRICAL ENGINEERS AND PHYSICISTS

An expanding program of teaching and research has created opportunities as instructor, assistant professor, and associate professor level in this large mid-eastern college. Your inquiries are invited. Box 500.

POSITIONS OPEN

SALES ENGINEER

Manufacturer's representative wants assistant to cover Connecticut territory. Must have sales experience and knowledge of electronic components. Salary, expense allowance and commission. Please furnish complete background information. Box 501.

MECHANICAL ENGINEER

Mechanical engineer to prepare technical manuscripts covering certain operations of the Los Alamos Laboratory. Applicant must have a B.S. degree in mechanical engineering and considerable experience in engineering and technical writing. Interested persons may write directly to Employment Director, P.O. Box 1663, Los Alamos, New Mexico.

ACOUSTICAL ENGINEER

Acoustical engineer wanted with experience in microphone or pickup design. Must know mechanical and acoustical circuits. Write details of experience and education to Engineering Department, Electro-Voice, Inc. Buchanan, Michigan.

ENGINEERS

(1) Mid-western manufacturer has opening for electronic engineer with background in electronic circuit design and instrumentation. Experience with pulse technique, servo-systems or telemetering procedures is desirable. Unlimited opportunity in a specialized field. Submit complete résumé and salary desired.

(2) Electrical designer with drafting experience and knowledge of mechanical layout. Experience in design of automatic test equipment desirable. State salary expected.

(3) Electro-mechanical draftsman. Must know symbols and be able to make composite layouts of electrical sub-assemblies. State salary desired. Write Box 502.

DEVELOPMENT ENGINEER

Development Engineer needed to design and develop electronic instruments for research work. Excellent opportunity for a man with degree and practical experience in test equipment construction. Write, giving full details of education and experience to Personnel Office, University of Chicago, 956 E. 58th Street, Chicago 37, Illinois.

INSTRUCTOR

Southwestern church-related University. Man with masters degree and teaching experience to teach radio theory and electronics. Salary range: $3,000-$3,300 for 9 months depending upon experience. Box 505.

ELECTRONICS ENGINEER

Electronics engineer for carrier telephone work by a St. Louis manufacturer of public utility equipment. Several positions open. Box 506.

ENGINEERS

Technical college in northern New York is adding several staff members to the Department of Electrical Engineering. Men with some experience in research or

(Continued on page 52A)

Report No. 2 from typical PARA-FLUX REPRODUCER users

18,720 SHELLAC RECORDS PLAYED CONTINUOUSLY WITH ONE PARA-FLUX REPRODUCER . . . WITHOUT EVEN THE POLISH RUBBED FROM THE DIAMOND POINT

Spot Sales, inc., N.Y.C. *REPORTS:*

"As you know, we put your Para-flux tone arm and pick-up through quite a severe test in our Store Broadcasting Operation. We are reproducing shellac phonograph records as well as vinylite transcriptions continuously for about twelve hours per day, six days per week. We use all of our phonograph records on one turntable and all of our vinylite transcriptions on another turntable. For four months we used your Para-flux pick-ups continuously and at the end of that time we had them examined under a microscope and neither pick-up showed any wear or distortion. We are using your turntable equipment, your equalizing network and Para-flux tone arms and pick-ups and the quality of our reproduction not only surprises but rather amazes everyone who hears it. Your equipment has completely solved our problems and has given us the most faithful service and quality of reproduction we have been able to find.

"I thought I would just drop you this note to let you know how excellently your equipment is serving us."

LOREN L. WATSON
President

RADIO-MUSIC CORPORATION
PORT CHESTER • NEW YORK

Engineers—Electronic

Senior and Junior, outstanding opportunity, small growing company. Forward complete resumés giving education, experience and salary requirements to

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The Institute of Radio Engineers
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Advanced
Home Study and Residence Courses in Practical Radio-Electronics and Television.
Approved for Veteran Training.

ARC
OMNI-DIRECTIONAL RANGES
RUNWAY LOCALIZERS
VISUAL-AURAL RANGES
SIMULTANEOUS VOICE
GCA
The MAGIC of VHF

All the outstanding advantages of VHF communication and navigation are combined in two new Systems designed and manufactured by Aircraft Radio Corporation.

THE TYPE 15A VHF OMNI-DIRECTIONAL RANGE RECEIVING SYSTEM provides an unlimited number of courses from the new VHF Omni-Directional Ranges, as well as operation on VHF Runway Localizers and Visual-Aural Airways Ranges. Simultaneous voice feature is included on these ranges. The *tunable* A.R.C. Receiver makes it possible to receive VHF communications on *any* frequency selected while in flight — no need for several receivers to cover the entire VHF band.

THE TYPE 18 VHF TRANSMITTING SYSTEM normally is used in combination with the Type 15 to provide complete 2-way VHF Communication — or it may be used alone for dependable, powerful VHF Transmission. Additional transmitters may be added to cover a wider range of frequencies if such coverage is required.

Units of the type 18 System have been Type-Certificated by the CAA for use by scheduled air carriers. Yet their light weight and moderate cost make them ideally suited to the operational requirements of executive-type aircraft. Other combinations of A.R.C. equipment are available to meet every operational need.

The dependability and performance of these VHF communication and navigation systems spells increased safety in flight, more efficient aircraft operation. Specify A.R.C. for your next installation.

Aircraft Radio Corporation
Boonton, N. J.

POSITIONS OPEN

(Continued from page 51A)

design and development in communications—electronics or physics are preferred. Salary and rank will be commensurate with training and experience. Box 508.

ENGINEER, SENIOR

Fine opportunity with a large midwestern radio corporation. Must have a minimum of three years' experience in loud-speaker design and materials used in manufacturing. College education in electronics or equivalent. In replying state age, education, experience, and salary requirements. Box 507.

PROTECT YOUR FUTURE
BUY YOUR EXTRA SAVINGS BONDS NOW

ELECTRONIC ENGINEERS WANTED

Engineers experienced in the development and design of electronic equipment.

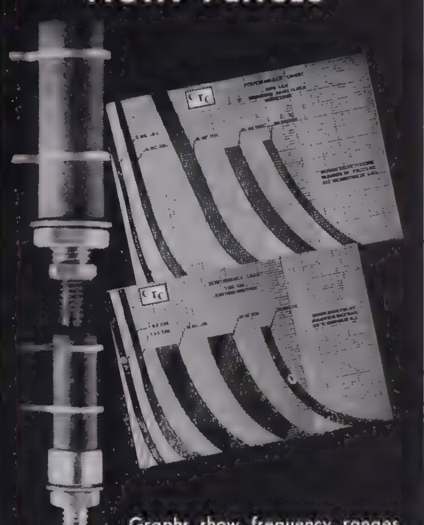
Opportunity for advancement with long-established and growing company. Laboratories and plant situated in pleasant, open surroundings on Long Island within half hour of New York City.

Also openings for Junior Engineers.

Write details of education and experience to

Personnel Office
HAZELTINE
ELECTRONICS
CORPORATION
Little Neck, L.I., N.Y.

THESE EXTRA SMALL COIL FORMS FIT INTO TIGHT PLACES



Graphs show frequency ranges covered by the five standard sizes of LSM and LS3 Coils. Write for full-size copies.

If small space is your problem — as in peaking coils in strip amplifiers, chokes, R. F. coils, oscillator coils, single-turned I. F. coils, etc.—you'll find space-saving one of many advantages in CTC Slug Tuned Coil Forms.

Coil forms are of quality paper-base phenolic, high frequency grade. Mounting bushings and ring-type terminals are brass, the bushings cadmium plated and terminals silver plated. Necessary mounting hardware is supplied.

DIMENSIONS

LSM — Extreme small size; only 27/32″ high when mounted; coil form, ¼″ diameter; mounts in single #18 hole; mounting bushing has 8-32 thread.

LS3 — Moderate small size; 1⅛″ high when mounted; coil form, ⅜″ diameter; mounts in single ¼ hole; mounting has ¼-28 thread.

WINDINGS

CTC LSM and LS3 Coil Forms are available unwound or in any of five standard windings: 1, 5, 10, 30 and 60 megacycles. They are also wound to specifications. (Standard slug is high-frequency type.) CTC will custom-engineer special coils of practically any size and winding . . . Let us talk over your requirements.

Turret Lugs
Split
Short
Swager
Double End
Terminal Board
Custom or Standard
The Guaranteed Components

CAMBRIDGE THERMIONIC CORPORATION
456 Concord Avenue, Cambridge 38, Mass.

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

JUNIOR ENGINEER

B.S.E.E., B.S.M.E. 1939, University of Paris. Age 28. Completing gradate work E.E. electronics at B.P.I. New York. 2½ years Army Signal Corps experience on RDF and communications equipment. Seeks position as Junior Engineer, physicist or instructor in New York City area. Box 130W.

TECHNICAL EDITOR

Former AAF officer with four years experience in writing and editing technical project reports and summaries, budget defenses, press releases, technical papers, etc. Assigned during this period to Radiation Laboratory, M.I.T. and Aircraft Radio Laboratory, Wright Field. Additional experience as sales engineer (2 years), radio and radar technician (2 years), and two years of college credits towards E.E. degree. Box 131W.

ELECTRONIC ENGINEER

B.E.E. Ohio State University, June 1948. Two years as electronics technician, U. S. Navy. Would like position in research or development. Vicinity New York or Cleveland. Box 136W.

ELECTRICAL ENGINEER

B.S. in E.E. 1944, University of New Brunswick (Canada). M.S. 1947 University of Western Ontario. Age 23. Single. Former officer Royal Canadian Signals. Limited experience in telephone work. Desires electrical engineering employment abroad, preferably in tropics. Box 138W.

RADIO ENGINEER

B.E.E. from N.Y.U. 1947; Graduate work B.S. in physics from C.C.N.Y. 1943. Signal Corps radio and repeater man telephone experience. Desires design and development work in radio, industrial electronics or communications. Box 137W.

ELECTRONICS ENGINEER

B.E.E. Drexel Institute, 1936. 11 years experience in radio transmitter design, electronic control circuits, bridge, oscilla-

(Continued on page 54A)

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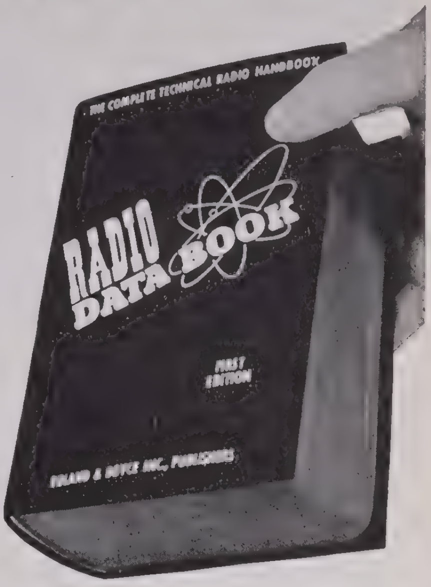

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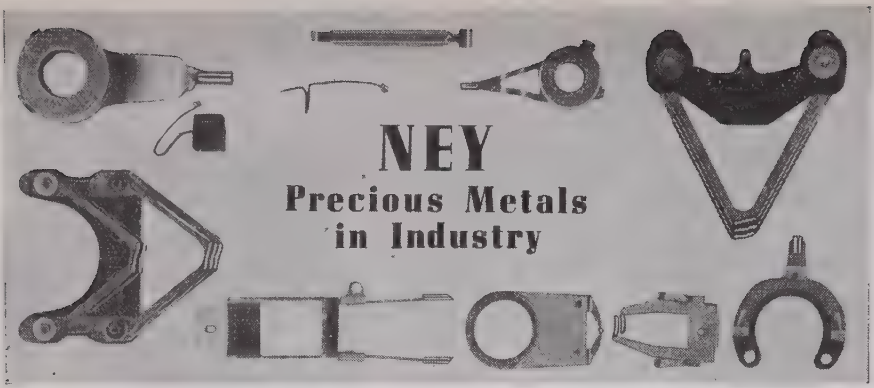

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SUCCESSOR TO
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An adaptation of the famous RH-7 crystal unit, RH-7C offers such advantages as:

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Positions Wanted

(Continued from page 53A)

tor, amplifier and null detector design. Investigation of foreign electronic equipment. Also new short wave therapy circuits. Box 123W.

ELECTRONIC ENGINEER—PHYSICIST

Electronic Engineer—Physicist. Graduated Princeton University. Wide research experience. Circuits, aircraft-servomechanisms, microwave plumbing, antennas. Able to take full charge of project from design specifications through preliminary manufacture. Prefer small aggressive company with aircraft connections. Box 141W.

ENGINEER

Engineer, 25 years old desires personnel or contact position where three years as a Signal Corps officers followed by two years of electronic laboratory and factory experience will pay dividends. Married and will locate anywhere. Box 142 W.

DESIGN AND DEVELOPMENT ENGINEER

Design and development engineer—Extensive experience FM and VHF, broadcast equipment and audio, some microwave. Both theoretical and practical background. Registered Professional Engineer. Employed but good reason for desiring change. Box 143W.

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ENGINEERS

The establishment of a new section in our research laboratory requires the services of Junior and Senior Electronic Engineers, Servo Engineer and Physicists.

An excellent opportunity to grow with this expanding group and receive responsibility commensurate with your ability.

EMPLOYMENT SECTION
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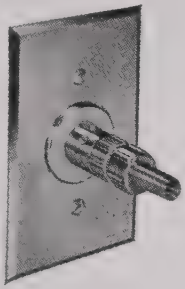
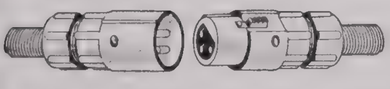
HIGH FIDELITY EV-635 MICROPHONE USES "XL" PLUG

Electro-Voice has equipped the new EV-635 High Fidelity Dynamic Microphone for studio and remote broadcasting, with the Cannon Type XL-3-11 Plug—a *quality* plug for a quality microphone.



Shown at left is the new XL-3-36 Wall Receptacle (pin insert) engaged with an XL-3-11 Plug. XL-3-36 is priced at $5.43 List; and XL-3-35 (socket insert) $4.93 List.

For a practical, low cost but high quality connector series having three 15-amp. contacts, choose the "XL". Four plug types and six receptacles with 3 adapter receptacles are available. Min. flashover voltage 1500 Volts.



Above are the two zinc plugs (Left) XL-2-12, List $1.20 and (right) XL-2-11, List $1.25.

No other small electric connector has all the features of the XL, including the safety latch lock.

XL Connectors are available from more than 250 radio supply houses throughout the U.S.A.

For complete information on the XL, write for Bulletins XL-347 and XL-PR1. Address Dept. B-377.

SINCE 1915

CANNON ELECTRIC
Development Company
3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.
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CANNON ELECTRIC CO., LTD., TORONTO 13, ONT.
WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

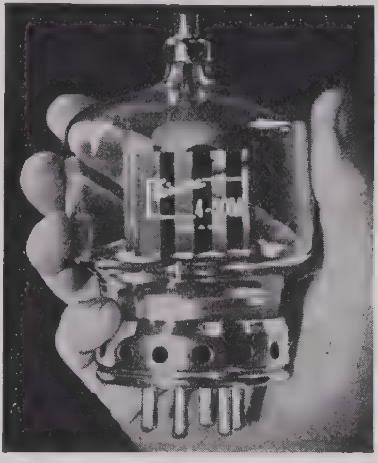
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 49A)

Tetrode Type 4-400A

A new 400-watt Eimac tetrode, known as type 4-400A, has been announced by **Eitel-McCullough, Inc.,** 189 San Mateo Ave., San Bruno, Calif.



This new tetrode is ruggedly designed, physically small, and of compact structure. Design features which contribute to its stability, long tube life, and economy of operation, are the short low-inductance leads, processed nonemitting grids, thoriated-tungsten filament, and plate of new Eimac material, Pyrovac.

The 4-400A is radiation-cooled, and is suggested for use in the special Eimac socket and air duct. According to the manufacturer, two of these tetrodes conservatively operated will provide over 1 kw. output power at 4000 plate volts on the 88–108-Mc. f.m. band.

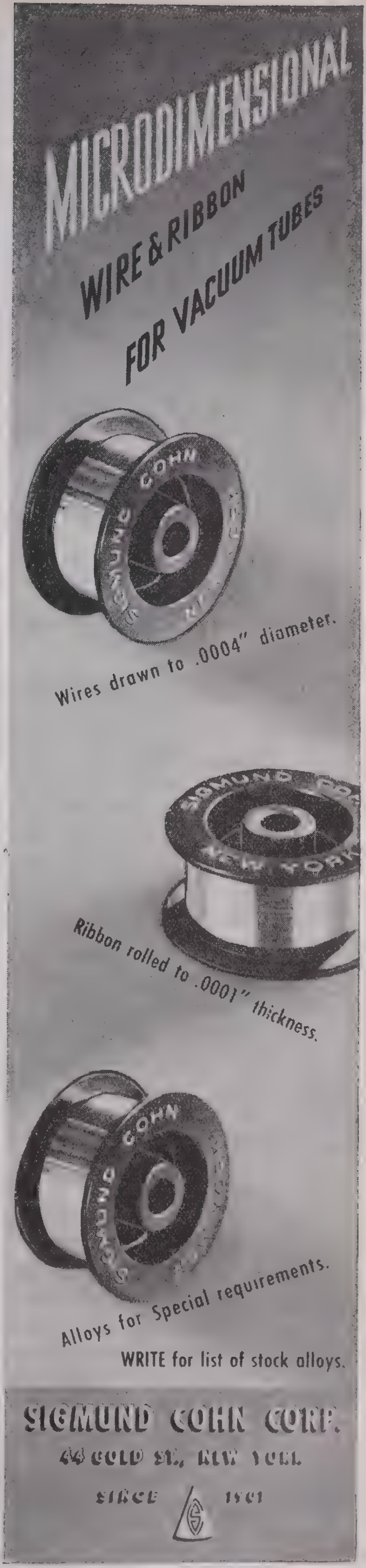
Permanent-Magnet Speakers

A standard line of permanent-magnet speakers for general replacement and sound-systems work has been announced by the Tube Department, **Radio Corporation of America,** Harrison, N. J.

Engineered to RMA standards, these speakers feature high-quality cones for rattle-free response, rugged dustproof and rust-resistant mechanical construction, powerful Alnico magnets, and moisture-proof centering. The line includes a controlled-resonance 12-inch speaker, a 4-inch and a 5-inch speaker, a 4-by-6-inch elliptical speaker, and a 2-by-3-inch elliptical speaker.

Complete specifications and descriptions of the speakers are included in Catalog Sheet 2F384R, available from RCA tube distributors or from the Renewal Sales Section, Tube Department, Harrison, N. J.

(Continued on page 56A)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WIRE & RIBBON
FOR VACUUM TUBES
Wires drawn to .0004" diameter.
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Alloys for Special requirements.
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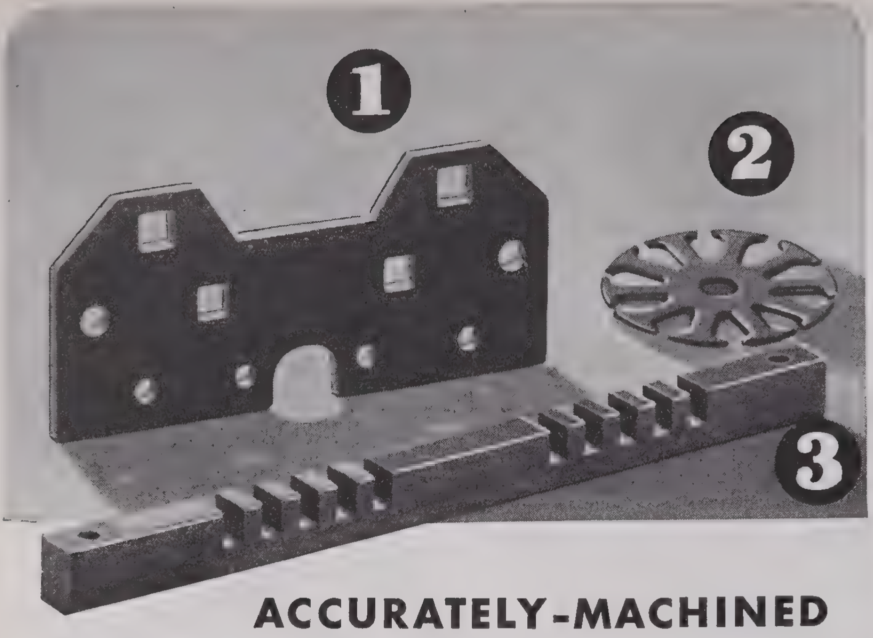

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TAYLOR LAMINATED PLASTICS

THE VERSATILITY of Taylor Laminated Plastics makes possible the fabrication of parts with structural, mechanical, and electrical properties to fit almost any engineering problem involving the mass-production of small, accurately-sized parts.

The three parts illustrated above, for example, selected at random from thousands of such parts being turned out daily in the modern Taylor plant, involve two different types of Phenol Fibre and one of Vulcanized Fibre. **No. 1** is a switch back machined from Phenol Fibre and having excellent moisture-resistance and electrical properties. **No. 2** is an end lamina for a fractional horsepower motor, punched and formed from Vulcanized Fibre. **No. 3** is a coil bar support for a secret electronic device which is sawed, milled, and drilled from Phenol Fibre having especially good insulating qualities and mechanical strength.

If your production problem involves great quantities of parts with light weight, great strength, and special insulating or dielectric qualities, let our engineers tell you what Taylor can do for you.

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News—New Products

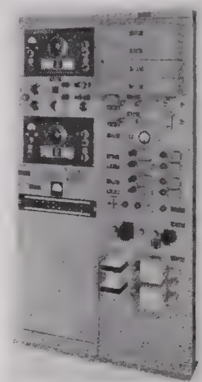
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 55A)

•

H & K Frequency-Shift Receiver Terminal

The Type A-4601 Dual-Diversity Receiver Terminal has been added to the line of frequency-shift equipment now being produced by the Communications Equipment Division of **Heintz & Kaufman, Ltd.,** 50 Drumm St., San Francisco, Calif.



This unit accepts a frequency-shifted signal from two communications receivers and converts it either to tone, neutral, or polar d.c. keyed in accordance with telegraphic intelligence. The recording device may be radiotype, teletype, or a high-speed telegraph tape recorder.

A crystal oscillator and b.f.o. unit provides stable high-frequency and beat-frequency injection voltages to both receivers. The audio response from each receiver is thus identical in frequency.

The input filters have a range of 1850 to 3250 cycles. The response is down 70 db at 1700 cycles, and 60 db at 3400 cycles. A frequency shift between 600 and 900 cycles may be used.

The A-4601 permits an improvement of 11 db in signal-to-noise ratio over make-break systems by virtue of using frequency shift alone, according to the manufacturer. Further gains are obtained under circuit conditions where noise and atmospherics are high. The gain of the H & K dual-diversity system over a single-channel make-break system approximates 22 db. Another advantage of the frequency-shift system is that it makes high-speed keying possible with no loss of selectivity.

The complete terminal is mounted in two relay racks each measuring 6 feet by 19 inches. It is designed for 110–125-volt operation, 60 cycles, and has a power requirement of approximately 150 watts.

Interesting Abstract

• • • The **Electronic Engineering Co. of California** has recently been organized by Burgess Dempster and R. B. Bonney with Headquarters at 2008 West Seventh St., Los Angeles 5, Calif. They are doing general electronic consulting and are also available to represent eastern firms who require technical representation in California. Mr. Dempster was formerly with the Magnavox Company and the Crosley Corp., and Mr. Bonney was previously with R. C. A. and Crosley Corp.

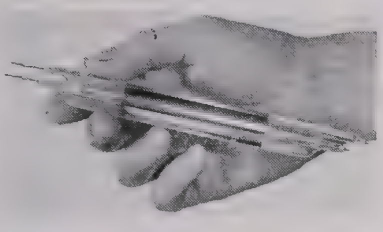
(Continued on page 57A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 56A)

New Geiger-Mueller Counter



A new Geiger-Mueller counter, Model D11, has been announced by **Instrument Development Laboratories,** 223 West Erie St., Chicago 10, Ill. This new counter was designed for use with recording instruments, and is all glass with a window thickness of 25 milligrams per square centimeter. Over-all dimensions of the counter are $8\times\frac{3}{4}$ inches, with an active length of 3 inches. Cathode material may be specified as copper or silver, and the central wire is made of 0.004-inch polished tungsten.

Interference Filters

A new series of heavy-duty radio-interference filters for wiring circuits, screened rooms, and industrial equipment is now available from **Solar Manufacturing Corp.,** 1445 Hudson Blvd., North Bergen, N. J.

Type EB series Elim-O-Stat filters are furnished in standard Underwriters'-approved heavy cadmium-plated-steel surface cabinets. Type EB filter assemblies have a noise elimination range of from 150 kc to 250 Mc., covering all frequencies used for radio communication and entertainment, as well as commercial television.

Descriptive literature is available upon letterhead request.

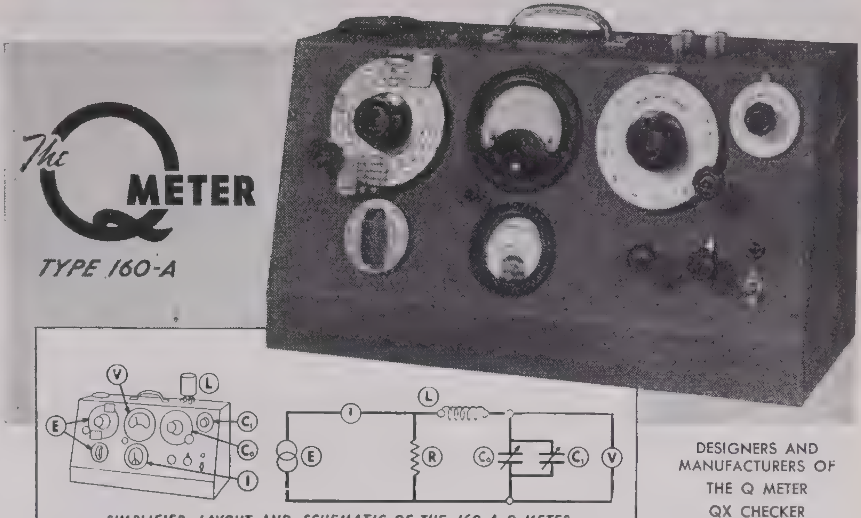
(Continued on page 58A)

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Mrs. Harriet P. Watkins, Industry Research Division, Proceedings of I.R.E., Room 707, 303 West 42nd St., New York 18, N. Y.** Photographs, and electrotypes if not over 2" wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

MANY FEATURES IN ONE INSTRUMENT

The Q METER
TYPE 160-A



SIMPLIFIED LAYOUT AND SCHEMATIC OF THE 160-A Q-METER

THE BASIC METHOD OF MEASUREMENT EMPLOYED IN THE 160-A Q-METER
An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance.
Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges. *Oscillator Frequency Accuracy:* ±1%, 50 kc.—50 mc. *Q-Measurement Range:* Directly calibrated in Q, 20-250. Multiplier extends Q range to 625. *Capacitance Range:* Main section (C_0) 30-450 mmf. Vernier section (C_1)+3 mmf, zero, —3 mmf.

DESIGNERS AND MANUFACTURERS OF
THE Q METER
QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
BEAT FREQUENCY GENERATOR
AND OTHER DIRECT READING TEST INSTRUMENTS

BOONTON RADIO Corporation
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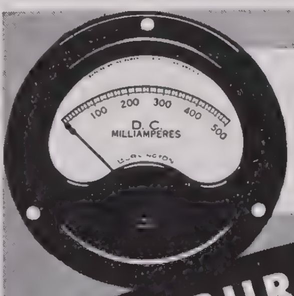
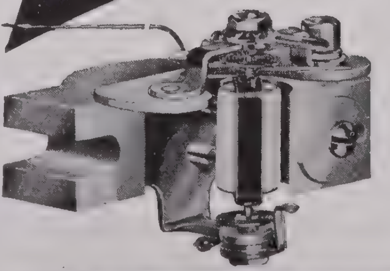


ONE OF A SERIES

ALNICO MAGNETS

WHY BURLINGTON PANEL INSTRUMENTS PROVIDE UTMOST RELIABILITY . . .



MAGNETS OF ALNICO are standard for all DC instruments because it is the most stable magnetic material available, having greatest resistance to effects of stray magnetic fields, vibration, shock and heat. All ranges AC and DC available in 2½", 3½", 4½", rectangular or round case styles and are fully guaranteed for one year against defects in workmanship or material. Refer inquiries to Dept. I 28.

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PREMAX

Elements For Rotary Beams . . .

- ***Light Weight***
- ***Durable***
- ***Adjustable***

Designed to meet the need for lightweight but sturdy elements for use in horizontal arrays and similar applications, Premax Corulite Elements are unusually light in weight and their special corrugated or reeded design provides exceptional strength and the rigidity so essential in horizontal installations.

Available in 5′ to 17′ lengths, or in special 10 and 20-meter kits. Fully telescoping and adjustable over 5′ length.

See your radio jobber. If he cannot supply you, write direct.

Premax Products
Division of Chisholm-Ryder Co., Inc.

Division Chisholm-Ryder Co., Inc.
4811 Highland Ave., Niagara Falls, N.Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 57A)

New Voltmeter

A recent addition to the line of measurement instruments manufactured by the **Electronic Measurements Corp.**, 423 Broome St., New York, N. Y., is the Model 120 Voltmeter illustrated below.

The manufacturer claims that this model gives wide resistance range (0.2 ohm to 300 megohms) and high a.c. voltage sensitivity (10,000 ohms per volt).

Other features include an a.c.-voltage frequency range of 30 cycles to 1 Mc.; special precision voltage multipliers, accurate to 1 per cent; and a rectifier battery replaceable without soldering iron. No external source of power is required for a.c. voltage measurements.

Miniature Precision Resistors

The **Shallcross Manufacturing Co.**, of Collingdale, Pa., has announced four new small-size Akra-Ohm precision resistors which afford interesting possibilities for designers of miniature equipment where the need is for small, close-tolerance units. Type 136, the smallest Akra-Ohm resistor yet produced by this manufacturer, has a maximum wattage rating of 0.25 and is only 1 5/32 inches long by 3/8 inch in diameter. Maximum resistance of this unit is 150,000 ohms. Standard tolerance is 1 per cent although closer tolerances can be furnished on special order, as can special impregnation for operation under highly humid conditions.

Types 137, 133, and 134 are 2-, 3-, and 4-section units with 3, 4, and 5 leads respectively and with 0.25 watts maximum load per section. Maximum resistance of 550,000 ohms is available in Type 133.

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

. . . and now the NEW Precision

Electronamic Test Master*

SERIES 10-20

**Combination
Tube PERFORMANCE Tester,
Battery Tester and
34 range AC-DC Circuit Tester**

** Reg. Pend. U. S. Patent Office*

* A tube tested for just one characteristic does not necessarily reveal overall performance capabilities. In the Precision Electronamic Tube Tester, the tube is electro-dynamically swept over a complete Path of Operation, on a sinusoidal time base which is automatically integrated by the meter in direct terms of Replace-Weak-Good.

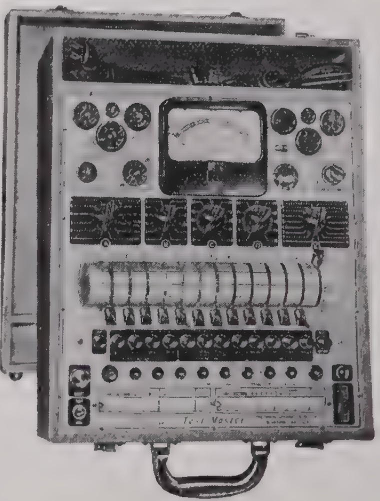
Affords highest practical order of obsolescence insurance thru use of the Precision 12 station Master Lever Element Selector System.

THE SERIES 10-20 TEST MASTER

is particularly engineered for general-purpose industrial and electronic maintenance, service and installation. Tests all modern standard receiving and low power transmitting tubes; including facilities up to twelve individual element prongs; dual-capped H.F. amplifiers, 5 & 7 pin acorn types, Noval 9 pin tubes, etc.

CIRCUIT TESTING FEATURES

34 self-contained ranges, to 3000 volts, 10 megohms, 12 amperes, + 64DB. • 400 microampere, 4⅝" meter • All standard functions at only two t.p. jacks • Push-button range selection.



MODEL 10-20-P in portable hardwood case (illustrated) $109.10

Also available in counter and panel mount models.
All models include test leads and ohmmeter batteries.

"Precision" Master Electronamic Test Instruments now on display at all leading radio equipment distributors. Write for the Precision 1948 catalog fully describing the Electronamic tube performance testing circuit.

**PRECISION
APPARATUS CO., Inc.
92-27 Horace Harding Blvd.
Elmhurst 12, N. Y.**

Export Division: 458 Broadway, N. Y. C., U.S.A.
Cables: MORHANEX

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Pulse Generator

A new instrument, designated as Model 471 Pulse Generator, is now being manufactured by **The Electrodyne Co.,** 899 Boylston St., Boston 15, Mass.

The output consists of rectangular-shaped voltage pulses, and the pulse is internally triggered for continuous operation from ½ to 1000 c.p.s. Provision is made for the use of an external triggering device which can be the type 208 oscilloscope or any source of positive pulses of at least 20 volts. There is also a position provided for generating a single pulse every time the switch is depressed.

Continuously variable pulse duration is available from 25 to 950 microseconds. The maximum output obtainable into a 10,000 ohm load is 50 volts, and 5- and 1-volt ranges are provided. The output impedance of the 50-volt range is approximately 1500 ohms, remaining relatively constant regardless of output-control setting. Approximate output impedances of the 5-volt and 1-volt ranges are 250 and 50 ohms respectively.

A three-step range switch and a single fine control provide ample spread adjustment for each of the pulse-frequency, pulse-duration, and amplitude ranges. Accuracy of each range is ±2 per cent of maximum value.

Cueing Attenuators

New and improved cueing attenuators have been designed by the **Shallcross Manufacturing Co.,** Collingdale, Pa.

These new units, which feature a special switching mechanism to transfer attenuator input to a pair of separate output terminals for cueing purposes, facilitate program switching and fading-in "on cue" without any increase in the diameter of the attenuator.

Any standard Shallcross ladder, bridged T, straight T, or potentiometer may be equipped for cueing action, including units as small as 1¾ inch in diameter. All controls are available with mounting by means of a single-hole ⅜-inch–32-thread bushing or two 6-32 or 8-32 screws on 1¼-inch or 1½-inch centers (except 1¾-inch diameter units).

(Continued on page 60A)

Light in Weight!

Combining minimum weight with small size, JOHNSON Type H Condensers are designed especially for aircraft transmitters. Simple and rugged in construction, JOHNSON Type H Condensers easily withstand heavy vibration. STEATITE end plates prevent any possibility of "short circuit loops" and permit panel mounting with both rotor and stator insulated from ground. Capacities and spacings are provided for low and medium power stages. Aluminum plates are .020" thick. End plates are 1½" square.

Type H JOHNSON Condensers

Excellent for police equipment, airline ground equipment, amateur equipment, test equipment, VHF and others.

They're small in size—great in performance!

For Further Details Write For Latest JOHNSON Catalog

JOHNSON a famous name in Radio

E. F. JOHNSON CO., WASECA, MINNESOTA

Sign of Transformer Reliability

KENYON For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!

Consult KENYON about your transformer problems.

See us at the I.R.E. show.

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

HOW LARGE IS A

BIG COIL?

This big recently produced Barker and Williamson coil measures 24" in diameter.

We don't know, but we do know that from less than ½ inch in diameter on up to a 2-foot inductor like the larger one shown here, the organization of electronic specialists at Barker and Williamson is set to give your requirements prompt, intelligent attention.

Engineering and production facilities at B&W are ample to take care of a myriad of varying coil requirements — big or little, a few at a time or a production run!

Write Department PR 28 *concerning your requirements.*

B&W

BARKER & WILLIAMSON, Inc.
237 Fairfield Ave., Upper Darby, Pa.

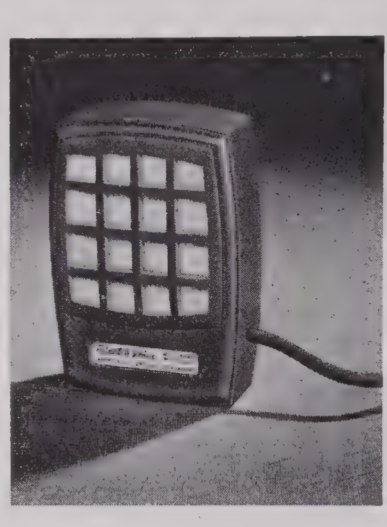
NEWS—NEW PRODUCTS

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

New Microphones in Crystal, Dynamic, and Carbon Types

A new multipurpose "Century" series of modern microphones for low-cost public address, paging, recording, and communications is announced by **Electro-Voice, Inc.,** Buchanan, Mich.



Designed for complete adaptability, the "Century" is available in a choice of three generating elements: crystal, dynamic, or carbon. It can be used in any position, and mobile communication models are fitted with a hook for dash mounting. This new microphone is made of diecast metal and finished in lustrous gray-brown. The dimensions are $3\times2\frac{3}{16}\times1$ inch.

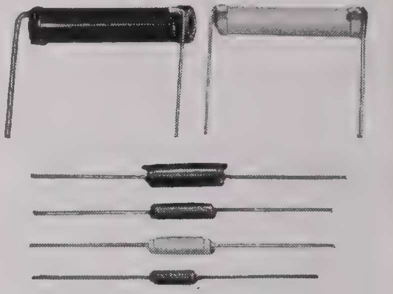
An optional slide-to-talk shorting switch is available on all three types, and an optional slide-to-talk relay control switch and hang-up hook available on the dynamic and carbon types, all at slight extra cost. A new reclining Desk Stand Model 415 and other accessories are also available for use with the "Century." For complete information write to the manufacturer for Bulletin No. 137.

* * *

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Mrs. Harriet P. Watkins, Industry Research Division, Proceedings of I.R.E., Room 707, 303 West 42nd St., New York 18, N. Y.** Photographs, and electrotypes if not over 2" wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

Radio Frequency Plate Chokes



Six new r.f. chokes have been developed by **Ohmite Manufacturing Co.** 4954, Flournoy St., Chicago, Ill., to cover the higher radio frequencies now in use by amateurs, police, communications facilities, and various other services. These new chokes are described in Bulletin 133 issued by the manufacturer.

Recent Catalogs

• • •On Model 61, direct reading v.h.f.-u.h.f. wattmeter, by **Bird Electronic Corp.,** 1800 East 38th St., Cleveland 14, Ohio.

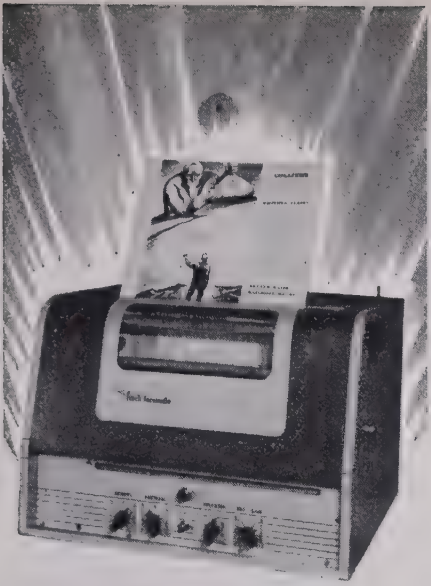
• • •On rack-and-panel-type connectors for radio and instrument applications, Bulletin No. D.P.-547, by **Cannon Electric Development Co.,** 3209 Humboldt St., Los Angeles, Calif.

• • •On electrical and scientific instruments developed by **James G. Biddle Co.,** 1316 Arch St., Philadelphia 7, Pa., the Biddle Instrument News, published on an average of four times each year. Write to the manufacturer, Dept. B-46, if you wish to receive future issues.

• • •On microwave equipment, a reference manual and catalog, by **DeMornay-Budd, Inc.,** 475 Grand Concourse, New York 51, N. Y. Copies will be sent free to all legitimate individuals and firms in the electronic and allied fields if requests are sent to DeMornay-Budd on firm stationery.

• • •On custom-built oscilloscope recorders, issued by **The Electrodyne Co.,** 899 Boylston St., Boston 15, Mass. Request for free copy should be made to the manufacturer on business letterhead.

• • •On resistors, an attractively illustrated file catalog issued by **Instrument Resistors Co.,** 25 Amity St., Little Falls, N. J. If interested, also ask manufacturer for leaflets on two new units not listed in catalog, Type WLA (one watt) and Type WLA5/8 (one-half watt).



finch

first in facsimile
for broadcasting and point-to-point communication!

FINCH TELECOMMUNICATIONS
INCORPORATED
SALES OFFICE:
10 EAST 40th STREET, NEW YORK
FACTORIES: PASSAIC, N. J.

ANOTHER *New* BROWNING DEVICE

OSCILLOSYNCHROSCOPE
MODEL OL-15A

Versatile laboratory instrument designed for observing phenomena requiring extended range amplifiers and a wide variety of time bases.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

WRITE TO
DEPT. C FOR
CATALOG

KNOW THE ENTIRE
BROWNING LINE
ENGINEERED for ENGINEERS

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

New Voltbox A.C. Power Supplies

The illustration shows one of the new models recently announced by **Superior Electric Co.,** 607 Laurel St., Bristol, Conn., as an addition to its line of power supplies. The two new units are designated as types UC1M and UC2M, and in appearance both are alike.

These new models offer features of lightness, pleasing appearance, and flexibility. Contained in the cast-aluminum case are a Powerstat variable transformer; an easily read voltmeter, accurate to 2 per cent; three output receptacles and a set of Superior binding posts; an "on-off" switch and "line-load" switch; renewable fuse; and a six-foot cord with plug.

For type UC1M the input is 115 volts, 50 to 60 cycles, one phase, and the output is 0–135 volts, 7.5 amperes; for type UC2M the input is 230 volts, 50 to 60 cycles, one phase, and the output is 0–270 volts, 3.0 amperes.

For users who already have a Superior Powerstat variable transformer type 116 or 216 in their possession, but require the features of the new Voltboxes, the *Voltbase* is available. For further information regarding these products and their uses, write to the manufacturer.

Tubular Capacitors

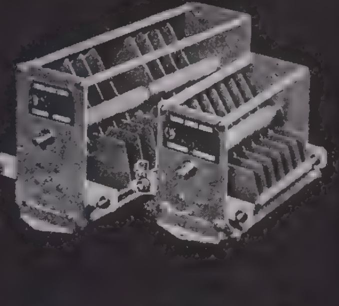
A complete line of phenolic-molded paper tubular capacitors, developed after four years of intensive research, has been announced by **Sprague Electric Co.,** North Adams, Mass.

Features of the new units include the facts that they are highly heat- and moisture-resistant, are noninflammable, are conservatively rated for operation from −40°C. to +85°C., and are mechanically rugged, according to the manufacturer.

Write to the Sprague Electric Co. for Bulletin 210 containing complete details on the new capacitors.

(Continued on page 62A)

BETTER
CONDENSERS



at lower cost!

Even though JOHNSON condensers offer you many outstanding advantages, they cost less than any other quality condenser.

Type C and D JOHNSON condensers are available in 52 different sizes with a wide variety of capacities and spacing.

FEATURES

Type C and D—Dual and Single

1. Sturdily constructed—heavy aluminum plates .051 thick.
2. Rounded plates for high voltage rating.
3. Steatite insulation. Large laminated phosphor bronze rotor brushes. Center rotor contacts on all dual models.
4. Heavy tie rods for frame strength and rigidity. Brackets for top or bottom mounting.
5. Spacers that permit reassembly for different capacity or voltage ratings.
6. Occupy less panel space because of their construction.
7. Both front and rear shaft extensions permit ganging.

For Complete Details Write For Latest JOHNSON Catalog

JOHNSON
a famous name in Radio
E. F. JOHNSON CO. WASECA, MINN.

NOW! SELF-CONTAINED, EXPERIMENTAL
SCHOOL & INDUSTRIAL LAB EQUIPMENT

Kepco Laboratory Multiple Power Supply Model 103, available separately.

Kepco Electronic Instruction Panel Model 104, available separately.

Now you can perform electronic experiments simply, easily with the Kepco Electronic Instruction Panel. Here is a teaching aid that graphically illustrates vacuum tube principles — enables all students to grasp fundamentals in the laboratory.

Extremely versatile, the Kepco Electronic Instruction panel covers a wide range of tubes, comes with a packet of 23 keyed interchangeable circuit charts, 3 master charts and 12 blank keyed sheets for additional experiments. Panel contains 3 octal tube sockets, 18 binding posts. By placing a keyed circuit diagram on the panel and wiring the circuit, students determine tube and circuit characteristics.

For a basic electronic instructional aid that vastly simplifies the teacher's task, it's the Kepco Electronic Instruction Panel!

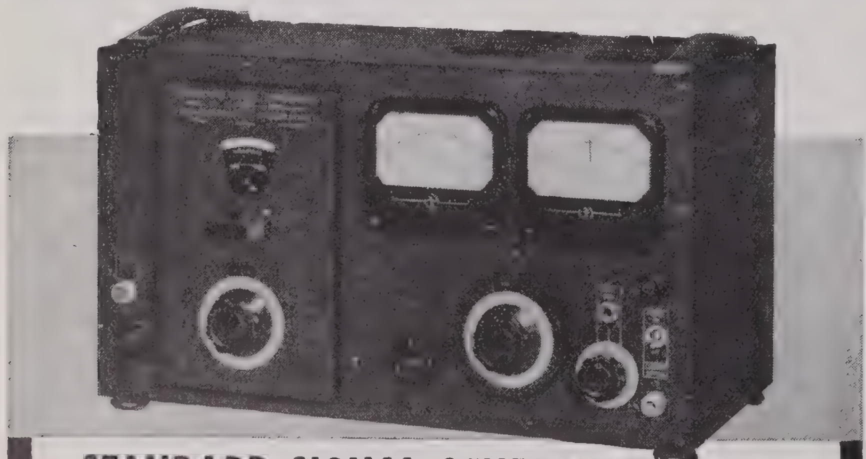
Now you can eliminate the use of cumbersome separate voltage supplies with the Kepco Laboratory Multiple Power Supply. Designed to be used with the Kepco Electronic Instruction Panel, this versatile, compact, easy-to-use unit supplies four commonly used voltages, is invaluable for the school or industrial laboratory.

CHECK THESE FEATURES:

Two continuously variable B supplies, adjustable from 0-300 volts at 120 m.a.
Variable (grid) supply, adjustable from minus 50 to plus 50 volts at 5 m.a.
6.3 volt filament supply at 5 amperes.
All connections made to sturdy, front panel binding posts.
Input: 105 to 125 volts, 50 to 60 cycles.
Two 5Y3 rectifiers, Two 6Y6 control tubes.
16" long, 8" high, 8¾" deep. Wgt.: 28 lbs.

WRITE FOR FULL INFORMATION TODAY!

Kepco LABORATORIES INC.
Electronic Instruments
142-45 Roosevelt Avenue
Flushing, New York



STANDARD SIGNAL GENERATOR Model 80

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.
OUTPUT: 0.1 to 100,000 microvolts.
50 ohms output impedance.
MODULATION: A M 0 to 30% at 400 or 1000 cycles internal.
Jack for external audio modulation.
Video modulation jack for connection of external pulse generator.
POWER SUPPLY: 117 volts, 50-60 cycles.
DIMENSIONS: Width 19", Height 10¾", Depth 9½".
WEIGHT: Approximately 35 lbs.
Suitable connection cables and matching pads can be supplied on order.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

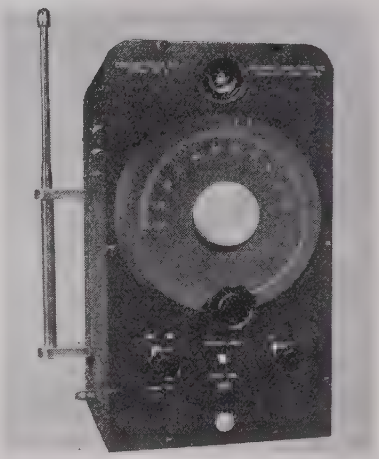
MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 61A)

Model S-7 Frequency Meter



A frequency meter especially designed for measurements in the 72–76 and 152–162 Mc. band is announced by **Browning Laboratories, Inc.,** 750 Main St., Winchester, Mass.

Designated as Model S-7, the new meter features accuracy in either band of 0.005 per cent, or 0.0025 per cent where minor precautions are taken, rendering measurements of control station and satellite transmitters possible in the above-mentioned bands. The meter is housed in a rugged steel cabinet and has an engraved aluminum panel. Finishes are black throughout. A whip antenna mounted at the side of the cabinet furnishes coupling to the transmitter and may be telescoped to form a convenient carrying handle. Charts supplied with the instrument show deviation from assigned frequency. This instrument is available in single or two specified frequencies in either or both bands. It operates from 117 volts a.c. or d.c. and consumes approximately 50 watts. The weight is 15 pounds and the dimensions are 13½ inches by 7⅝ inches by 6⅞ inches.

New Miniature Electron Tube

The Tube Department, **Radio Corporation of America,** Harrison, N. J., has announced availability of the RCA-6BH6 sharp-cutoff miniature pentode intended primarily for service in mobile equipment where heater-current drain is an important consideration, and in a.c.-d.c. a.m. and f.m. receivers. In the latter, it is especially useful as a limiter or as a driver for a ratio detector. Features of the 6BH6 are its high transconductance, its low grid-plate capacitance, and its 6-volt, 150-milliampere heater.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Volt-Ohm-Mil-Ammeter

The Triplett Electrical Instrument Co., of Bluffton, Ohio, announce the availability of a new Combination Tube Tester–Volt-Ohm-Mil-Ammeter, designated as Model 3480.

This instrument was designed as a combination tester for conclusive tube testing and complete voltage, current and resistance analyses. The tube tester has a fully balanced, multipurpose test circuit for emission, short- and open-element tests. This unit tests all receiving-type tubes, gaseous rectifiers, resistor and ballast tube continuity, and pilot lamps. A speed-roll tube chart, conveniently located simplifies testing. The volt-ohm-mil-ammeter provides a.c.-d.c. voltage ranges 0 to 1200 at 10,000 ohms/volt for d.c. and 200 ohms/volt for a.c.; d.c. ma. 0 to 120; d.c. amp.: 0–12; ohms: 0–1000–100,000; megohms: 0–1–50; output: capacitor in series with a.c. volts.

(Continued on page 64A)

1948
March 22 - 25
Grand Central Palace &
Hotel Commodore
New York City
I.R.E. National Convention
Radio Engineering Show - Exhibits

DIALCO

PILOT LIGHT ASSEMBLIES

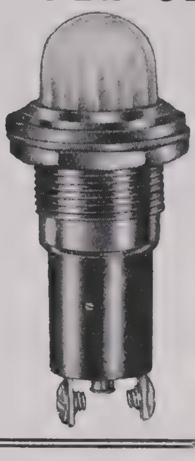
PLN SERIES—Designed for NE-51 Neon Lamp

Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
- 110 or 220 VOLTS
- EXTREME RUGGEDNESS
- VERY LOW CURRENT

Write for descriptive booklet

The DIAL LIGHT CO. of AMERICA
FOREMOST MANUFACTURER OF PILOT LIGHTS
900 BROADWAY, NEW YORK 3, N. Y.
Telephone—Spring 7-1300



LABORATORY TEST EQUIPMENT by FREED

No. 1010 Comparison and Limit Bridge. Self contained. A.C. operated.

No. 1020 Direct Reading Megohmeter up to 1.000.000 megohms. Self contained. A.C. operated.

No. 1040 Wide Range Vacuum Tube Voltmeter.

No. 1030 Direct Reading Low Frequency "Q" Indicator — "Q" .5 to 500 — Frequencies from 50-50 000 cycles.

No. 1110 Incremental Inductance Bridge.

SEND FOR COMPLETE CATALOG

FREED
TRANSFORMER CO., INC.
Instruments Division
78 SPRING STREET NEW YORK 12, N. Y.

PICKERING UNIFORMITY

EVERY Pickering Cartridge which leaves our laboratory has been carefully tested for the following characteristics, the allowable limits for which are shown:

FREQUENCY RESPONSE • ±2 db, 40-10,000 cps
WAVEFORM DISTORTION • 1 per cent maximum
OUTPUT LEVEL • 70 millivolts, ±2db
TRACKING PRESSURE • 15 grams max. at 40 and 10,000 cps

IN ADDITION, optical inspection of the stylus polish and shape, mechanical inspection of the moving parts, and electrical inspection of the pickup coil has been made on each unit.

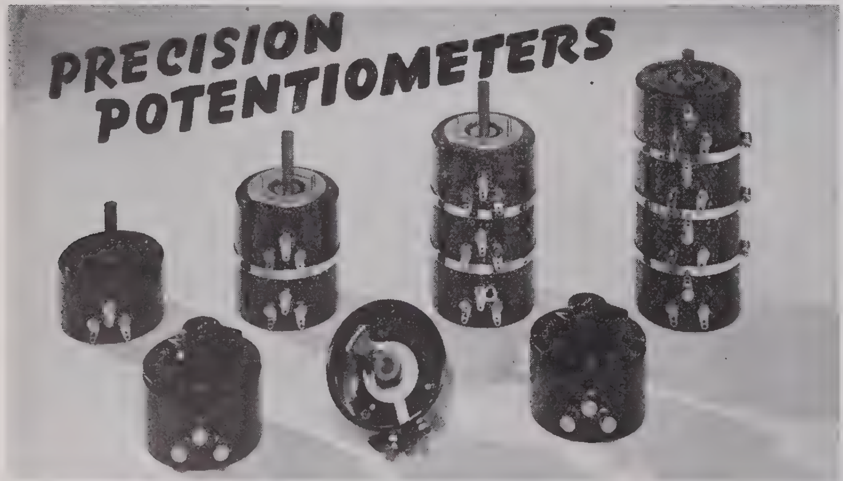
REGULAR sampling tests reveal absolute stability, amazing ruggedness, and complete insensitivity to the effects of temperature and humidity.

NO OTHER PICKUP CAN QUITE MATCH THIS PERFORMANCE

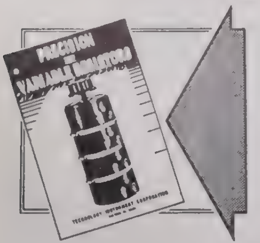
Available with diamond or sapphire stylus from all principal distributors

Pickering & Company, Inc.
29 West 57th Street New York 19, N. Y.

PRECISION POTENTIOMETERS



NOTE THESE STANDARD FEATURES



- Contacts of Paliney #7 and Ney-Oro #28
- Two Rotor Take-Off Brushes
- Adjustable Stop—360° Rotation
- Ganging Simplicity
- Dustproof

WRITE FOR BULLETIN 208 TODAY

TECHNOLOGY INSTRUMENT CORP.
1058 MAIN ST., WALTHAM 54, MASSACHUSETTS

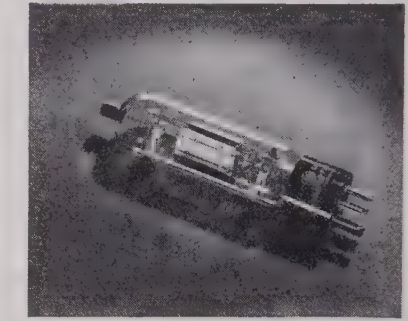
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 63A)

New Tube Type GL-5674

A new "split-anode" electrometer tube, which the manufacturer claims will measure reliably current as low as a millionth of a billionth of an ampere, has been made available by the Tube Division, Electronics Dept. of **General Electric Co.**, Schenectady, N. Y.



This new tube is expected to prove of value in nuclear, medical, and industrial research which involves the measurement of minute currents. It is a two-tubes-in-one device in which the electrodes (control grid and plate) are cut in two and connected so as to function as a pair. Measurement is then the differential response between the two halves of the tube. Since sporadic effects influence both parts alike, the difference between the two responses is independent of incidental fluctuations.

Recent Catalogs

• • • On radio and electronic equipment, a new 48-page supplement to the regular catalog by **Allied Radio Corp.**, 833 West Jackson Blvd., Chicago 7, Ill. The new supplement No. 114 as well as the regular master catalog No. 112 can be obtained from Allied Radio Corp.

• • • On a new Wow Meter, Model 115, issued by **Furst Electronics**, 800 West North Ave., Chicago 22, Ill. Ask for illustrated catalog sheet, form 115-1, which gives description and specifications.

• • • On their complete line of stock moulded plastic knobs control handles, instrument knobs, etc., an illustrated catalog issued by **Rogan Brothers**, 2500 West Irving Park Blvd., Chicago 18, Ill.

• • • On a new series of direct-reading temperature-calibrated portable potentiometers. Complete technical description with limits of error and prices are included in Bulletin No. 270, available on request from the **Rubicon Company**, 3664 Ridge Ave., Philadelphia 32, Pa.

ANOTHER *New* BROWNING DEVICE

FM-AM TUNER
MODEL RJ-12

Superb FM reception; quality AM reception. Single antenna for both bands. Separate RF and IF systems on both bands. Armstrong FM circuit.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

WRITE TO DEPT. C FOR CATALOG

KNOW THE ENTIRE BROWNING LINE
ENGINEERED for ENGINEERS

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

Improved
PRESSURE TRANSDUCER

The improved type 4512 Giannini Pressure Transducer is smaller and lighter than standard instruments. This instrument combines smaller size with high outputs and accurate readings. Even at low pressures, it retains all of its accuracy.

This absolute, differential, or gauge-type Pressure Transducer is available in ranges up to 40 psi. The new type 4512 is available for immediate delivery.

Write for engineering details.

G. M. Giannini & Co. Inc.
285 WEST COLORADO STREET, PASADENA 1, CALIFORNIA
OFFICES: NEW YORK, NEW YORK — DAYTON, OHIO

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Recent Catalogs

• • •On capacitors and radio noise filters, a complete new 1948 catalog is now available from **Solar Capacitor Sales Corp.,** 1445 Hudson Blvd., North Bergen, N. J. Ask for Catalog SC-2.

• • •On a newly designed Tru-Sonic Model P-52FR Co-Spiral Speaker and other items in the Tru-Sonic line, by the **Stephens Manufacturing Corp.,** 10416 National Blvd., Los Angeles 34, Calif. Write for Bulletin #109.

• • •On Model SC-9A Lead-Shielded Sample Changer and Preamplifier, by **Tracerlab, Inc.,** 55 Oliver St., Boston, Mass. This equipment is fully described in issue number 7 of *Tracerlog,* which is available upon request to Tracerlab, Inc.

Type 116 Polar Recorder

The commercial availability of a polar recorder has been announced by **Airborne Instruments Laboratory, Inc.,** 160 Old Country Road, Mineola, N. Y.

Originally designed to plot aircraft-antenna radiation patterns, this recorder charts voltage on either a linear or a logarithmic scale as radial distance against angular position. Identified as A.I.L. Type 116, the device will be custom built to each customer's specific requirements. Provision of a permanent ink record (readily reproducible), rapid writing speed coupled with low pen overshoot, and preciseness of angular positioning are the recorder's outstanding features. It appears to be readily adaptable to any measurement task recordable in terms of polar co-ordinates, and can be provided in either portable or rack-mounted form. Complete descriptive material is available from the Laboratory.

(Continued on page 66A)

LABORATORY EQUIPMENT

Standard R.F. Radio Noise Generator, 100 kc to 160 mc
(Pulse Type)

1. Pulse width approximately 0.003 microseconds
2. Frequency spectrum nearly flat up to 160 megacycles (down 3 db at 160 mc)
3. Spectral amplitude 25 microvolts per kilocycle bandwidth
4. No tuning elements used
5. Output continuously variable by means of calibrated attenuator
6. Pulse repetition rate variable from 30 to 1100 pps

R. F. Attenuator, DC to 1000 megacycles

1. Attenuation 20 db plus 0 or minus 2 db
2. Input impedance 50 ohms resistive
3. Can be connected in series to give multiples of 20 db attenuation
4. Type N connectors

Other values of attenuation for broad frequency bands up to 4000 megacycles can be furnished

Signal Generators for the range of 1000 to 2000 megacycles, 1000 to 3000 megacycles and 2000 to 4000 megacycles, calibrated output

Signal Generator for X band

Signal Generator for portions of S band

Ferris model 18 B microvolter, 20 to 150 megacycles

Wavemeter for X band, TS 33/AP

Wavemeter, 340 to 1000 megacycles

G.R. precision wavemeter, 16 kc to 50 mc

X band power load, TS 108/AP, 150watts

Fluxmeter TS 15/AP

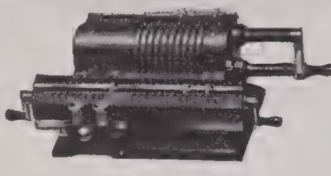
Compact Radar Transmitter Receiver, 2400-2700 megacycles, 110 v 60 cps

Complete marine radar, SD-3, 220 mc, 110 v 60 cps.

RC tuned Signal Generator, 20-20,000 cps, Hickok 198

●

ELECTRO IMPULSE LABORATORY
66 Mechanic St. Red Bank, New Jersey



SINCE 1874
ORIGINAL-ODHNER
"THE MACHINE TO COUNT ON"

A HANDY CALCULATOR

NEW BACK TRANSFER DEVICE SPEEDS UP CALCULATIONS

HERE'S THE ANSWER to the engineer's demand for a low priced, fast calculator. Entirely portable. Unexcelled for sturdy construction. Hundreds of auxiliary uses in large organizations. Keep one on every desk, where quick calculations are necessary.

Available from stock.

Ivan Sorvall, Inc.
210 Fifth Ave., New York 10, N.Y.

Ask for Bulletin AQ-23

Specify
MYCALEX
LOW LOSS INSULATION

Where high mechanical and electrical specifications must be met.

MYCALEX 410
(MOLDED MYCALEX)

makes a positive seal with metals . . . resists arcing, moisture and high temperatures.

27 years of leadership in solving the most exacting high frequency insulating problems.

MYCALEX CORPORATION OF AMERICA
"Owners of 'MYCALEX' Patents"
Plant and General Offices: Clifton, N.J.
Executive Offices: 30 Rockefeller Plaza
New York 20, N.Y.

NEWS—NEW PRODUCTS

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 65A)

New Postwar Bridge

The postwar models of the Wheatstone bridges offered by **Industrial Instruments, Inc.**, 17 Pollock Ave., Jersey City 5, N. J., are produced along the same sturdy lines as the previous models but are more conveniently operated. Distinctive bar knobs, used in the place of the former fluted round knobs, are easier to hold and manipulate. Also, the knobs are continuously rotatable.

Two postwar models are offered: (1) The standard portable Wheatstone bridge complete with batteries and hardwood case, ready to operate; and (2) with Murray and Varley loops. The indicator is a galvanometer of the well-known moving-coil type with a pointer dial having fifteen 1-millimeter divisions each side of zero, and with an adjusting knob and safety clamp. The galvanometer sensitivity is 1 microampere per millimeter division. Separate binding posts are provided for use of an external galvanometer if required, and also for the use of the bridge as a resistance decade.

New Microphone Models

Two new floor-stand microphones designed by Shaeffer of Hollywood have been announced by **Universal Microphone Co.**, Centinela at Warren Lane, Inglewood, Calif.

The Model ST-3 is a modern, three-legged stand designed with a low center of gravity for added stability, and with rubber cushioned feet to minimize floor noises and to absorb vibrations. Sturdily built to withstand abuse, its extended height is 72 inches and its closed height is 40 inches.

Model ST-R is the same as ST-3 except for a heavier, round base. Prompt delivery is promised on both models.

New Tubular Trimmer Design

Types 531 and 532 Tubular Trimmers which are announced by **Erie Resistor Corp.**, 640 West 12 St., Erie, Pa., have low minimum capacitance, high ratio of tuning range, require very little space, and are economically priced. The capacity range is 1–8 $\mu\mu$fd.; the power factor is 0.1 per cent of maximum; and rated voltage is 350 volts d.c. The dimensions are approximately $\frac{3}{8}$-inch diameter by $1\frac{5}{16}$-inch long at maximum capacitance. Capacitance is varied by changing position of plunger inside high-temperature thermoplastic dielectric tube. Absence of peaks and valleys in capacitance change curve and relative slowness of capacitance change makes for accurate alignments of sets without overshooting.

Trimmers are mounted by a standard cadmium-plated clip nut which is the ground terminal. Erie Type 531 is for panels 0.015 to 0.039 inch thick; Erie Type 532 is for panels 0.040 to 0.065 inch thick.

* * *

Interesting Abstracts

• • • **International Instruments, Inc.**, New Haven, Conn., a new organization formed from the Instrument Division of the M B Manufacturing Company, of the same city, announces that the company is well established in the production of a specialized line of midget meters and allied equipment.

* * *

• • • A new industry service, announced as the Resistor Analysis Council, by **International Resistance Co.**, at 401 No. Broad St., Philadelphia, Pa., is being headed by Wm. H. Knowles, Jr. Interested engineers and designers may have the resistor requirements of their products analyzed by sending as much pertinent data as is available to the Resistor Analysis Council.

* * *

• • • The firm of **Don C. Wallace and William H. Wallace** is now fully established in new offices in the Bendix Bldg., 1206 Maple Ave., Los Angeles 15, Calif. As manufacturers' representatives, this firm will continue to represent eastern factories in the western territory.

* * *

• • • Continuing promotion of f.m. and television, **Westinghouse Electric Corp.**, with headquarters at 306 Fouth Ave., Pittsburgh 30, Pa., plans to expand facilities of the Sunbury, Pa., plant to handle and control production of television receivers, according to an announcement made by Walter C. Evans, vice president.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

1.6-Mc. Interval Timer Counter Chronograph

For applications which require an accurate time interval measurement, the new Model 450 Interval Timer manufactured by the **Potter Instrument Co., Inc.,** 136–56 Roosevelt Ave., Flushing, N. Y., will measure intervals in steps of 0.625 microsecond. The instrument will register, directly, intervals up to 1 second. Longer periods can be recorded by using an external counter to record the number of times the cycle is repeated.

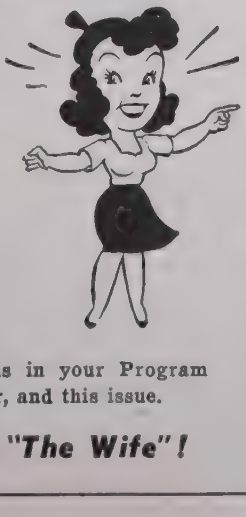
Model 450 is actuated by positive pulses which can be easily derived from detectors such as photoelectric equipment and closing contacts. The time base included in the instrument consists of a 1.6-Mc. crystal oscillator. The oscillator, electronic switch, and counter decades are made up as individual units which plug into the chassis. Indication is by means of neon indicator glow lamps.

(Continued on page 68A)

* * *

Program for Ladies

at the
1948 I.R.E.
National
Convention



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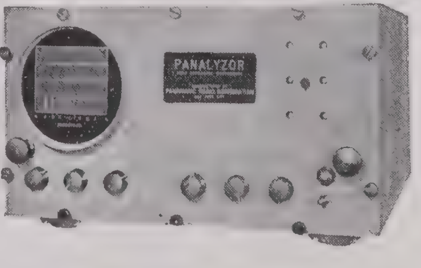

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Maximum Scanning Width	50KC	100KC	200KC	1MC	1MC	6MC	1MC	10MC	20MC
Input Center Frequency	455KC	455KC	455KC	5.25MC	10.2MC	30MC	5.25MC	30MC	30MC
Resolution at Maximum Scanning Width	2.5KC	3.4KC	4.4KC	11KC	11KC	25KC	11KC	75KC	91KC
Resolution at 20% of Maximum Scanning Width	1.9KC	2.7KC	4KC	9KC	7.5KC	22KC	7.5KC	65KC	75KC

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NEWS—NEW PRODUCTS

The manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 67A)

D.C. Power Supplies

A new line of hermetically sealed high-voltage, low-current d.c. power supplies has been announced by the **Condenser Products Co.,** 1375 No. Branch St., Chicago 22, Ill.

PS-1
Condenser Products Co
Chicago, Ill.
CP

The HiVolt PS-1 and PS-2 Supplies, both of which transform 118 volts a.c., 60 cycles, to 2,400 volts d.c., are now in production. The PS-1 is designed to charge Plasticon capacitors for use in electronic photoflash and spectrograph analysis equipment. The PS-2 is intended for use in radiation counters, oscilloscopes, and television receivers. The manufacturer states that HiVolt 4,000-volt and 10,000-volt supplies will be announced at an early date.

◆

Signal Generator

The Triplett Electrical Instrument Co., Bluffton, Ohio, announces a new f.m.–a.m. signal generator, known as Model 3433, with frequency coverage from 100 kc. to 120 Mc. in 10 fundamental bands, plus an additional 50 Mc. from a fixed oscillator, giving fundamental coverage to 170 Mc.

This signal generator features constant deviation by using a fixed-frequency reactance-modulated oscillator; an output meter for measuring relative r.f. output; double-copper-plated steel shielding, greatly minimizing r.f. leakage; coaxial-cable output lead; ladder attenuator; high-r.f.-voltage output jack; high a.f. output available; air trimmer capacitor and permeability-adjusted oscillator coils; voltage-regulated power supply; heterodyne detector; and external a.m. modulation.

The case measures 15 11/32 inches by 11 1/32 inches by 8 1/4 inches. Power Source: 115 volt, 50 to 60 cycles a.c.

New Graphic Recorder

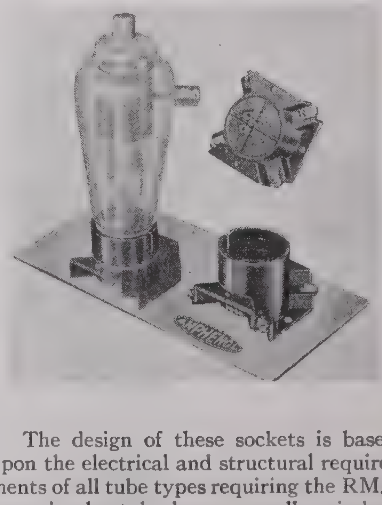
The **Servo-Tek Products Co.,** 247 Crooks Ave., Clifton, N. J., has announced a new type of position recorder which is declared to be capable of recording almost any mechanical motion or position. It is known as the "Servograph," a graphic recorder utilizing a 10-inch circular chart with an inking pen which is motivated from a remote point by war-proven synchros, or self-synchronous motors.

It is claimed that accuracy is better than 1 per cent for 360-degree transmitter rotation. Models are available for operation from a source of 115 volts at a frequency of either 60 or 400 cycles. Full mechanical clock drives and synchronous 115-volt 60-cycle electric drives are available for chart speeds of 12 hours, 24 hours, or 7 days. Multiple recording may be obtained by the use of two pens for two independent simultaneous recordings.

◆

Electron-Tube Socket

To meet the requirements of manufacturers of electronic equipment, the new molded-bakelite sockets, designated as No. 146-116, have been developed by the **American Phenolic Corp.,** 1830 So. Fifty-fourth Ave., Chicago 50, Ill.



The design of these sockets is based upon the electrical and structural requirements of all tube types requiring the RMA super-jumbo tube base, as well as industrial 411 and 412 tube bases which have the same pin arrangement but with smaller shell diameter. Socket contacts are of high-conductivity material and of a unique cloverleaf design presenting four lines of contact to the tube pin. Repeated tests are claimed to indicate a contact resistance of considerably less than 0.001 ohm may be expected at current levels as high as 25 amperes.

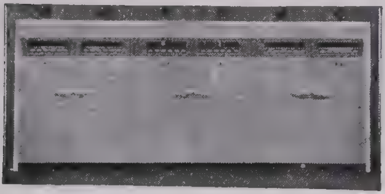
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

KW Television Transmitter

Development of General Electric Television transmitters, Type TT-6-A and TT-6-B, with a 5-kw. visual transmitter and a 2½-kw. aural transmitter for operation on television channels 1 through 13, has been announced by the Transmitter Division, Electronics Dept., **General Electric Co.,** Electronics Park, Syracuse, N. Y.



Low-level plate modulation features the electrical design and affords advantages which include: low-power modulator; linear modulation characteristic; high percentage-modulation capability; stable grounded-grid linear amplifiers; elimination of vestigial-sideband filter unit.

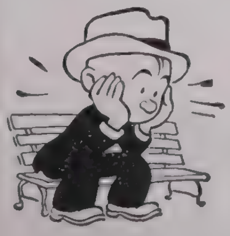
Physically, both the high-band transmitter (TT-6-B) and the low-band transmitter (TT-6-A) are arranged in three adjacent cubicals and occupy a space 16 feet long, 3 feet deep and 7 feet high. The aural transmitter, which incorporates the phasitron modulator employed in all General Electric's postwar f.m. broadcast transmitters, is contained in one cubical, with the visual transmitter occupying the other two cubicals.

P.M. Speakers

Correction

The type L-301 and L-401 speakers now being produced by the **William J. Murdock Co.,** 158 Carter St., Chelsea 50, Mass., which were publicized on page 48-A of the December, 1947, issue of the PROCEEDINGS, should have been designated therein as *permanent-magnet speakers.*

Don't be a Park Bench Sitter!



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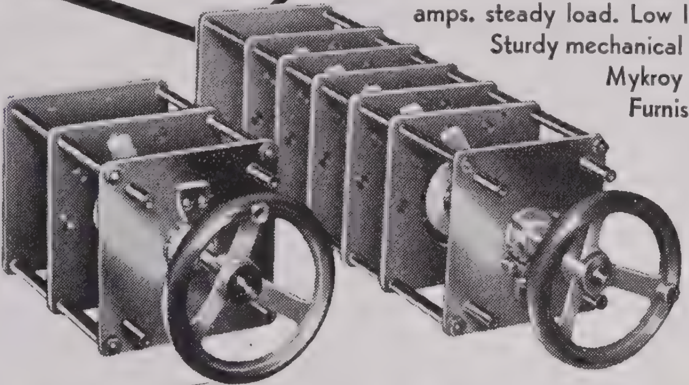
New Type 1250
R. F. SWITCH

High r. f. current carrying capacity 50 amps. max. intermittent load; 30 amps. steady load. Low loss factor. Sturdy mechanical design . . . Mykroy insulation Furnished in any number of decks.



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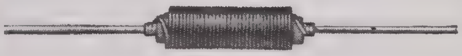

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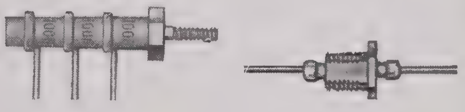

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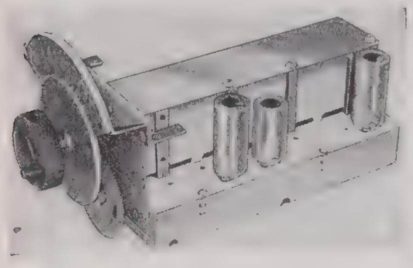
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

Improved Inputuner

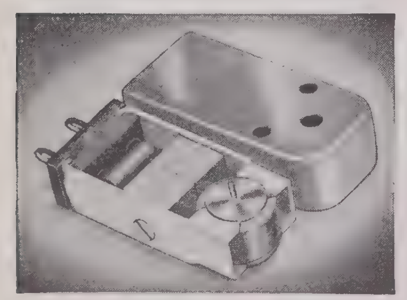
A new model of the Inputuner with several refinements over previous models is announced by **Allen B. DuMont Laboratories, Inc.**, 2 Main Ave., Passaic, N. J. This packaged r.f. head is available to television custom-built and line-production set manufacturers alike, eliminating costly problems and establishing in advance the major items of cost.



The Inputuner is a compact, rugged assembly as easy to install as a speaker. It requires no aligning, adjusting, or calibrating. Built around the Mallory-Ware Inductuner and including all necessary components for the complete r.f. head, it provides for continuous tuning in the 44–216-Mc. range. This means the coverage of all 13 television channels plus the f.m., amateur, aviation, telephone, and commercial services in that range without a break. Only one tuning knob is required for both coarse and fine adjustments.

◆

Magnetic Pickup

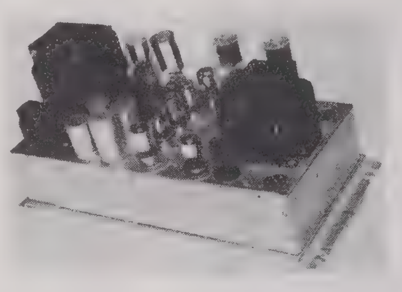


The **Clarkstan Corp.**, 11927 W. Pico Blvd., Los Angeles 34, Calif., has recently announced a new variable-reluctance pickup which is claimed to be a high-fidelity, wide-range device of extreme simplicity and ruggedness. The stylus can be instantly removed and replaced by the fingers without the use of tools. This pickup has a flat frequency response beyond f.m. requirements. The needle, which weighs 31 mg., is the armature and is the only moving part. A high-impedance winding is standard, but the unit can be had in impedances of 5, 50, 250, and 500 ohms.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Model 10-D Amplifier

The newest addition to the line of Brook high-quality audio amplifiers is the Model 10-D now being manufactured by **Brook Electronics, Inc.**, 34 DeHart Place, Elizabeth, N. J.



This amplifier is a 30-watt rack-mounting unit with 75-db gain, equipped with volume control and on-off switch on the front panel. As in all other amplifiers produced by this company, Model 10-D uses triodes throughout.

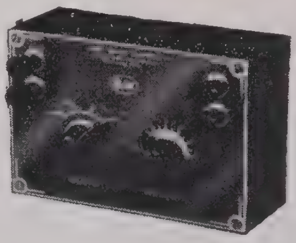
Designed essentially for broadcasting stations, recording studios, and high-quality public-address installations, this audio amplifier provides frequency response from 20 to 20,000 cycles within 0.2 db. At 5 watts output, harmonic distortion is only 0.6% and inter-modulation distortion is only 0.2%. Total distortion is claimed to be under 2½% at full 30-watt output. The power supply is self-contained. Noise level is 70 db below full output. Power available for external tuner or preamplifiers is 250 volts at 90 ma. and 6.6 volts at 5 amperes.

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Mrs. Harriet P. Watkins, Industry Research Division, Proceedings of I.R.E., Room 707, 303 West 42nd St., New York 18, N. Y.** Photographs, and electrotypes if not over 2″ wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

Sine Wave Clipper

A new Sine Wave Clipper has recently been announced by **Barker & Williamson,** Upper Darby, Pa., which will be welcomed by many engineers interested in audio-frequency circuits.



This new instrument provides a test signal particularly useful in examining the frequency response and transients of audio circuits. Designed to be driven by an audio oscillator, the clipper provides a clipped sine wave—hence the name *Sine Wave Clipper*.

By feeding the output of the clipper into audio equipment under test and in turn introducing the equipment's output into an oscilloscope, the experimenter or engineer may quickly view and analyze distortion introduced by the amplifier.

A sine-wave analysis after every change in a component becomes time-consuming and tedious. By means of the clipper, however, the effect of making changes in a circuit may be seen instantly and thus guide the course of development in the proper direction. The routine use of the clipped sine wave, in addition to sine-wave measurements, makes for a more complete check on the stability of equipment in regular operation.

An illustrated instruction book accompanies each Sine Wave Clipper. Complete information on this new device is available from the manufacturer.

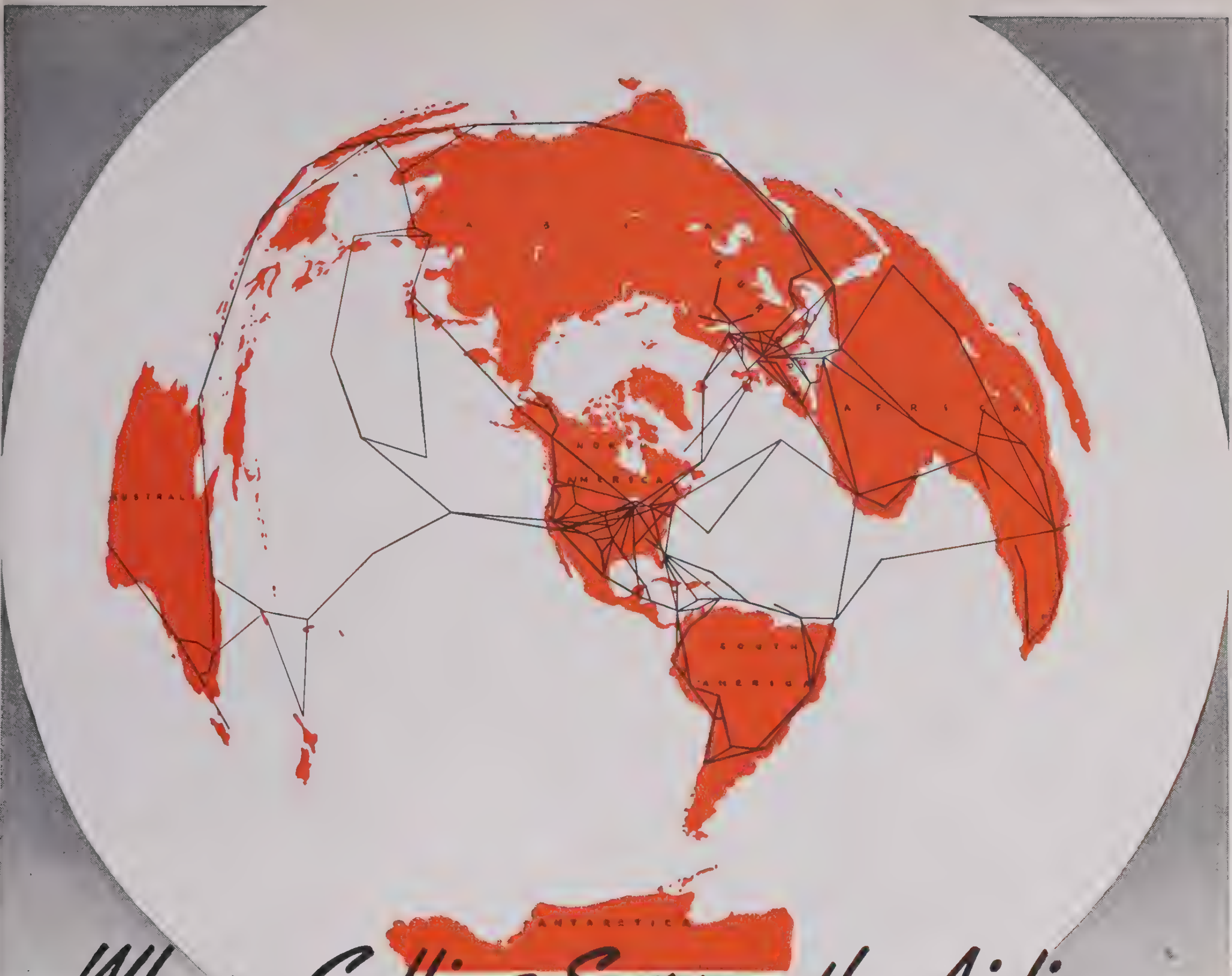
◆

New Broadcast-Station Light

A new indicator light, Type "Q," designed especially for radio broadcasting stations, film studios, and applications where controlled warning lights are required has recently been put on the market by **Cannon Electric Development Co.,** 3209 Humboldt St., Los Angeles 31, Calif.

The new light is available in 24 volts, 15 c.p. or 115 volts, 10 watts. It may be wired in multiple for several locations so that all will operate simultaneously. The left, or green, light is illuminated for 10 seconds and then goes out, when the red light (at right) glows and the panel is illuminated with "On The Air" or other brief wording adaptable to the use.

(Continued on page 26A)



Where Collins Serves the Airlines

The chart above indicates main routes of airlines using Collins radio communication equipment in the air, on the ground, or both. This tremendous acceptance had its beginning in the middle thirties, and is the result of early and never-ending Collins research and development in the field of aviation communications.

The airlines whose routes are shown include Air France, All American Aviation, American, American Overseas, Braniff, British Overseas, Chicago & Southern, Colonial Airlines, Eastern Air Lines, FAMA (Argentine Republic), Hawaiian, Northwest, Panagra (Pan American-Grace), Pan American World Airways System (Latin American division, Atlantic division, Pacific-Alaska division), Pennsylvania-Central, Peruvian International, Quantas (Australia), Royal Dutch, Sabena (Belgium), SILA — SAS — ABA (Scandinavian Air Carriers), South African, TACA Airways Agency Aerlinte Eireann (Irish), Trans-Australia, Transcontinental and Western, United, and Western.

Our own planes are in constant use, testing equipment of advanced Collins design for Government and commercial aviation. A recent and notable example of accomplishment is the Collins 51R VHF airborne receiver and attendant instrumentation, which equip an airplane for navigational use of the new omnidirectional range system. This equipment was designed and thoroughly tested in 1946, and was demonstrated to the airlines throughout 1947. As a result, Collins has been awarded the majority of the contracts which have been let to the time this announcement is written.

IN RADIO COMMUNICATIONS, IT'S . . .

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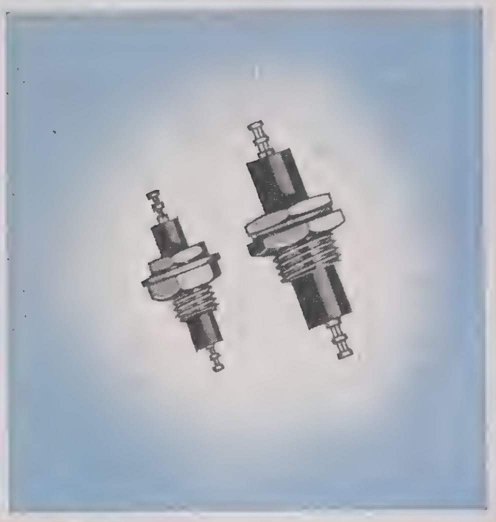
a tricky
feed-thru problem

Feeding an R. F. potential through the wall of a cavity oscillator presented many difficulties. Not only was space at a premium, but extreme changes in humidity, temperature and other service conditions had to be met.



THE ANSWER

C.T.C. 1795B Insulated Feed-Thru Terminals fulfilled every requirement. Design-features like these show you why: *Rugged construction that withstands loosening under vibration or shock . . . approved phenolic insulating material, JAN type LTS-E-4 . . . brass bushings, cadmium plated . . . brass thru-terminals, silver plated for easy soldering.*

SPECIFICATIONS

The 1795B mounts in a ¼″ hole, and has an over-all length of approximately ⅞″. C.T.C. Feed-Thru Terminals are available in additional sizes. The 1795A is similar to the 1795B, but with an over-all length of 1″. Also similar in design and function are X1771A and X1771B, but larger in size and mounting in a ⅜″ hole. Breakdown voltages, at 60 cycles R.M.S., are:

1795A . . . 3800V X1771A . . . 8200V
1795B . . . 3200V X1771B . . . 6000V

Catalog No. 200 contains details of C.T.C. standard electric and electronic components, together with full information on our custom-engineering service. Write for it today.

Visit us
at Booth 222
IRE National
Convention,
March 22-25,
Grand Central
Palace, New York

Custom or Standard
The Guaranteed
Components

Swager
Double-End Lugs
Split
Short
Turret
Terminal Board

CAMBRIDGE THERMIONIC CORPORATION
456 Concord Avenue, Cambridge 38, Mass.

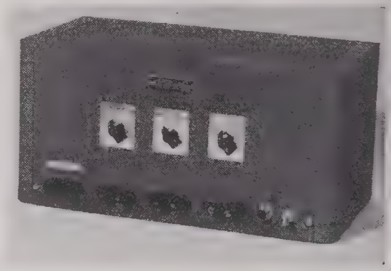
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 22A)

Multiple Power Supply

The 103 multiple power supply was developed by **Kepco Laboratories, Inc.,** 142–45 Roosevelt Ave., Flushing, N. Y., to meet the need for a source of power that would supply four commonly used voltages from a single compact unit. This multiple power supply eliminates the cumbersome use of three, possibly four, power units to supply heater, plate, and grid voltages. The power supply is particularly designed to be used in the study of the characteristics of vacuum and gas-filled tubes as well as the characteristics of electronic circuits employing these tubes.



The power supply contains two continuously variable B supplies delivering from 0 to 300 volts at currents up to 120 ma., one variable C supply delivering from −50 to +50 volts at 5 ma., and one heater supply delivering 6.3 volts at 5 amperes.

The two B supplies originate from a common power transformer and are controlled by a special circuit containing two 6Y6 control tubes. Each supply will deliver from 0 to 300 volts at 60 ma., or 120 ma. together. The ripple voltage is less than 5 millivolts throughout the entire range of the operating voltage. The supplies are isolated from the chassis to allow grounding of the positive terminal if necessary without affecting the C supply. The voltages are controlled from the front panel.

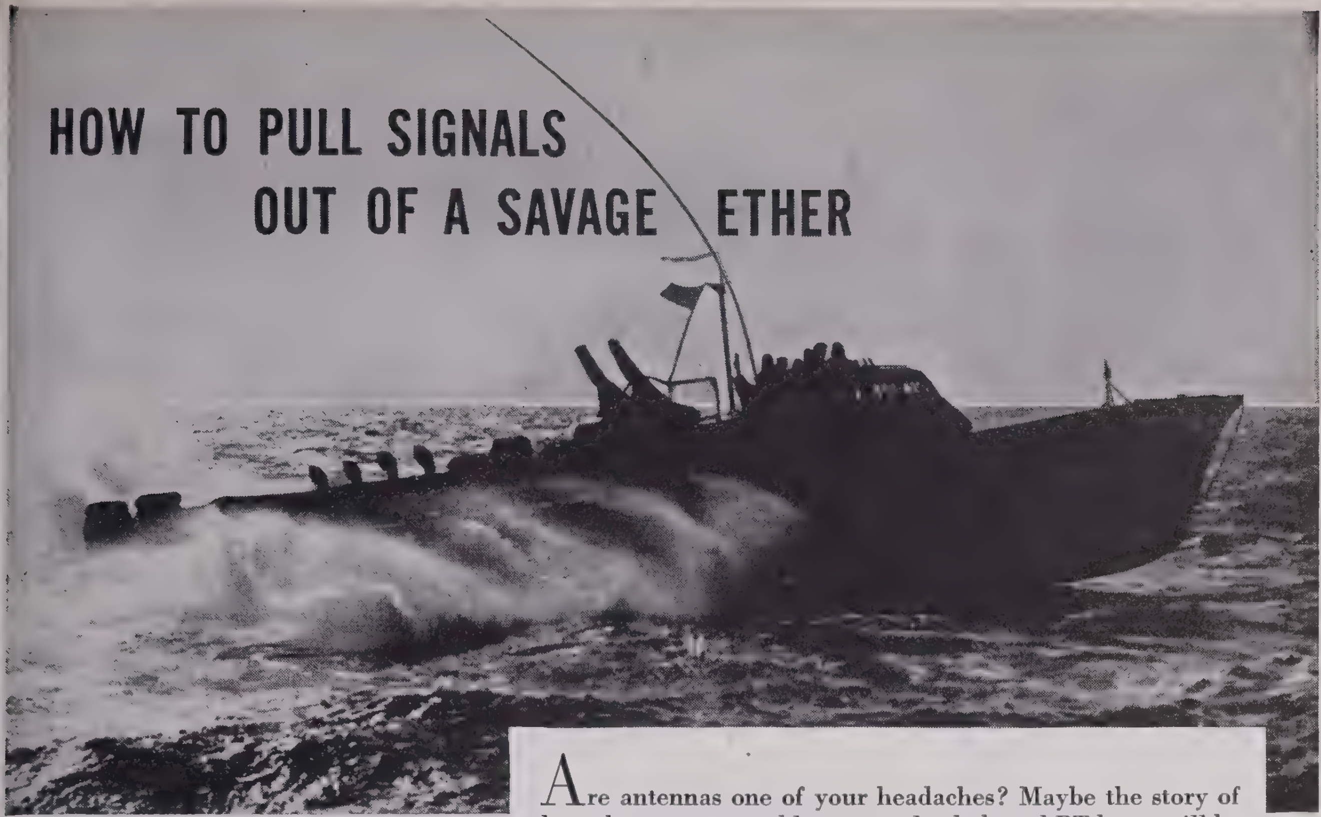
The C supply originates from an entirely separate power transformer and rectifying circuit. A special resistor network allows a continuously variable voltage from −50 volts to +50 volts at 5 ma. The multiple supply is available, upon request, with the C voltage variable from −150 volts to +150 volts at no extra cost. The ripple voltage is less than 1 millivolt throughout the operating range. The C voltage is controlled from the front panel.

Recent Catalogs

• • • On amplifiers, systems, phonographs and accessories, Catalog P9-47A by **David Bogen Co., Inc.,** 663 Broadway, New York 12, N. Y.

(Continued on page 46A)

HOW TO PULL SIGNALS OUT OF A SAVAGE ETHER



Roaring into action on fighting PT boats, Premax Monel antennas defied salt spray, weather, and whipping wind.

Are antennas one of your headaches? Maybe the story of how the antenna problem was solved aboard PT boats will be of some help to you.

PT antennas had to fight corrosive salt air and water. They needed strength and stiffness to withstand whipping winds and plunging boats. They had to function in arctic cold and tropic heat.

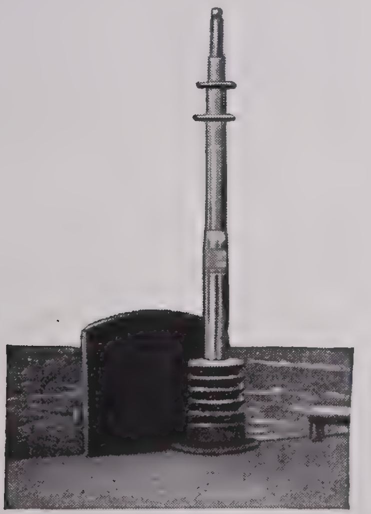
An answer was worked out for the Navy by Premax Products Division of Chisholm Ryder Co., Inc., Niagara Falls, N.Y. It consisted of telescoping tubular antennas, made of sections of seamless tubing furnished by the Superior Tube Co., Norristown, Pa.

The metal that met the combination of conditions?—Monel.* To quote Premax engineers:

> *"Monel has been found to be the most practical material for radio antennas. Sudden shocks do not affect its toughness . . . its fatigue strength exceeds the limits of mild steel or all brasses and bronzes.*
>
> *"Rigid tests by both Government and private agencies have shown Monel antennas to be dependable and satisfactory under all conditions."*

Do you have an electrical problem that can be solved by the combination of properties obtainable in Monel . . . or the other INCO Nickel Alloys?

All are strong, tough, and corrosion resistant. In addition, each has special properties needed for special jobs. Write us describing your problem. Our technical assistance is yours whenever you ask for it.



Premax Monel Antennas are built in multiple sections of tough, cold-drawn Monel tubing, telescoped one inside the other. Above illustration shows antenna in fully telescoped position.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

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INDEPENDENCE from Tower Trouble... at INDEPENDENCE, MO.

KIMO

USES A TRUSCON

SELF-SUPPORTING

TOWER 187 FT. HIGH

The scientific design, quality materials and skilled workmanship that were put into KIMO's Truscon Radio Tower enable it to serve its midwest audience with maximum efficiency.

Truscon experience encompasses every modern radio tower need. There are hundreds of Truscon Radio Towers in America and foreign lands, and each tower exactly meets specific requirements. The knowledge gained from such a wide diversity of installations assures you highly competent engineering service.

Truscon Radio Towers are available in guyed or self-supporting types, either tapered or uniform cross section, for AM or FM broadcasting. Experienced Truscon radio tower engineers will be glad to help solve your radio tower problems of today and tomorrow.

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YOUNGSTOWN 1, OHIO
Subsidiary of Republic Steel Corporation

Manufacturers of a Complete Line of Self-Supporting Radio Towers . . . Uniform Cross-Section Guyed Radio Towers . . . Copper Mesh Ground Screen . . . Steel Building Products.

SECTION MEETINGS

ATLANTA SECTION

"Pulse DME in the Air Navigation Program," by H. I. Metz, Civil Aeronautics Administration; December 19, 1947.

BUFFALO-NIAGARA

"A Universal Auto Radio Receiver Featuring a New Type of Automatic Station Selection," by V. H. Wiley, Colonial Radio Corporation; December 17, 1947.

CHICAGO SECTION

"New Developments in Electronic Air Navigation and Traffic Control," by E. A. Post, United Air Lines, Inc.; November 21, 1947.

"Omnidirectional Range Multifrequency Navigation Receiver," by E. W. Sheridan, Bendix Radio Division; November 21, 1947.

"Signal Communication for Supreme Headquarters Allied Expeditionary Forces," by P. J. Moore, Signal Corps Reserve; December 19, 1947.

CLEVELAND

"Intermodulation Effects," by H. C. Williams, Ohio Bell Telephone Company; December 11, 1947

CONNECTICUT VALLEY

"The Application of Capacitors for Power Factor Correction," by J. S. Williams, Westinghouse Electric Corporation; January 13, 1948.

DALLAS-FORT WORTH

"Navy Airborne Radar Equipment," by H. E. McDaniel, United States Navy; December 18, 1947.

"The Megacycle Meter," by J. B. Mintner, Measurements Corporation; December 29, 1947.

DAYTON

"Dielectric and Induction Heating," by H. Toner, Westinghouse Electric Company; January 6, 1948.

LOUISVILLE

"Operation of The Institute of Radio Engineers," by W. R. G. Baker, 1947 President, The Institute of Radio Engineers; January 9, 1948.

MONTREAL

"Design of Broadcast Antenna Tuning and Phasing Equipment," by E. Farmer, Canadian Marconi Company; January 14, 1948.

NEW YORK

"Industrial Application of High-Power Ultra-Sonics," by S. Y. White, Consulting Engineer; January 7, 1948.

PHILADELPHIA

"Reproduction of Sound," by H. F. Olson, RCA Laboratories; January 8, 1948.

PITTSBURGH

"Traveling Wave Tubes," by J. R. Pierce, Bell Telephone Laboratories; October 13, 1947.

"Recent Developments in Television Transmitter Equipment," by L. Mauntner, Allen B. DuMont Company; November 10, 1947.

"Electronic Heat," by H. Toner and M. Montague, Westinghouse Electric Corporation; December 8, 1947.

"Electronic Computers," by J. W. Mauchly, Eckert-Mauchly Computer Corporation; January 12, 1948.

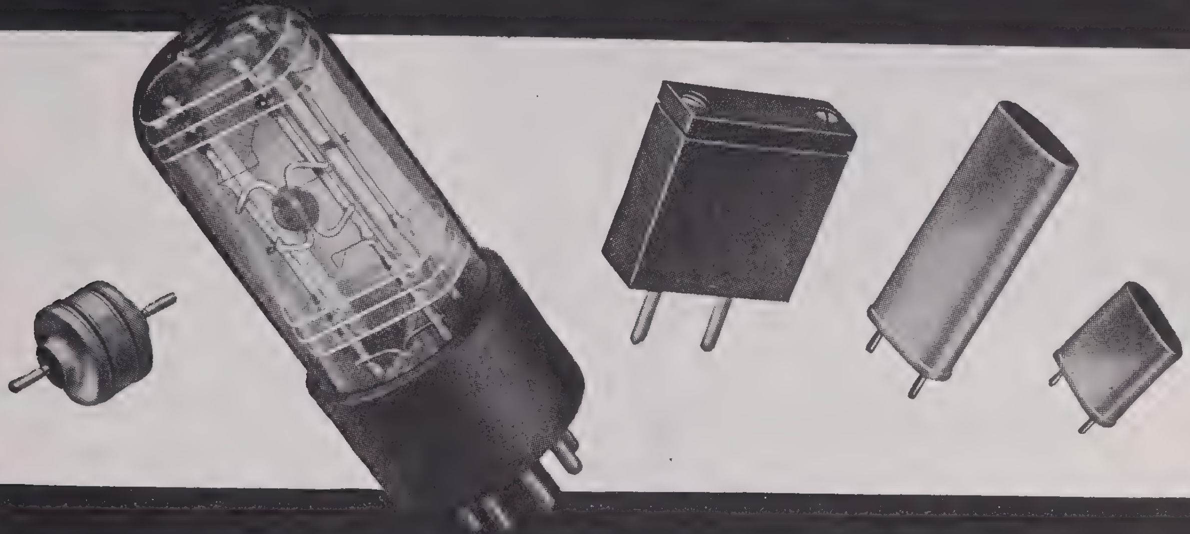
PRINCETON

"Pulse Code Modulation," by L. A. Meacham, Bell Telephone Laboratories; December 11, 1947.

"Communications Theory," by W. G. Tuller, Melpar, Inc.; January 8, 1948.

(Continued on page 36A)

Select a CRYSTAL UNIT as easily as you would a vacuum tube!



10 standard crystal types—between 1.2 and 50,000 KC

THE new Western Electric standardized line of quartz crystals will eliminate many of your circuit design problems. This new line consists of ten crystal types—listed in the table at the right—for operation within specific *frequency* ranges. Each of these ten crystal types consists of a number of separately coded crystal units which are designed to operate, with nominal tolerances, within specific *temperature* limits.

Whether you're concerned with frequency standards, mobile radio, point-to-point radio systems, commercial airline communications, AM or FM broadcasting, police, ship-to-shore systems, military communications or radar, you'll find that the job of selecting the proper Western Electric crystal unit is as simple as that of choosing a standard vacuum tube.

TYPE	FREQUENCY
20J	1.2 to 10 kc
21N	16 to 100 kc
21E	90 to 300 kc
22D	200 to 500 kc
22C	300 to 1,000 kc
24A	2,000 to 10,000 kc
22A	3,950 to 10,000 kc
24B	4,000 to 15,000 kc
22B	5,000 to 15,000 kc
23A	15,000 to 50,000 kc

For complete data on Western Electric crystals—designed by Bell Telephone Laboratories—send the coupon below.

Western Electric

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Gentlemen:
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THE *New* SHURE "SONODYNE"

A DYNAMO AMONG DYNAMIC MICROPHONES

Here is *the* microphone in its class—a high-output moving-coil dynamic that was designed to outperform... outsmart... outlast even higher priced microphones. The "Sonodyne" features a multi-impedance switch for low, medium, or high impedance-plus a high output of 52 db below 1 volt per dyne per sq. cm. It has a wide range frequency response (up to 10,000 c.p.s.) and semi-directional pickup. Mounted on swivel at rear, can be pointed 90° for non-directional pickup.

The "Sonodyne" is ideal for all general purpose use, including public address, communications, recording, and similar applications.

Multi-Impedance Switch for **LOW, MEDIUM, or HIGH** Impedance

HIGH OUTPUT (–52 db)

WIDE RANGE FREQUENCY RESPONSE (up to 10,000 c.p.s.)

Shure Patents Pending

MODEL "51" **CODE: RUMON**

LIST PRICE . . . $37.50

SHURE

SHURE BROTHERS, INC.
Microphones & Acoustic Devices
225 W. HURON ST., CHICAGO 10, ILL. • CABLE ADDRESS: SHUREMICRO

SECTION MEETINGS

(Continued from page 34A)

Rochester

"The Future of Radio and Television in Rochester," by R. H. Manson, Stromberg-Carlson Company; December 9, 1947.

"Christmas, Today and Yesterday," by E. M. Poteat, Colgate-Rochester Divinity School; December 17, 1947.

"Behind the Instrument Dial," by L. F. Parachini, Weston Electrical Instrument Corporation; January 8, 1948.

San Diego

"Some Propagation Factors at Television and F.M. Frequencies," by L. G. Trolese, United States Navy Electronics Laboratory; December 2, 1947.

"Multivibrator Uses and Designs," by D. J. Green, Consolidated-Vultee Aircraft Corporation; January 6, 1948.

Election of Officers; January 6, 1948.

Seattle

"Problems in Radio Telemetering," by H. A. Price, Boeing Aircraft Company; December 29, 1947.

Election of Officers; December 29, 1947.

Washington

"Microwave Repeater Research," by K. G. Jansky, Bell Telephone Laboratories, Inc.; January 12, 1948.

Williamsport

"Applications and Techniques of Printed Circuits and Miniature Electronics," by C. Brunetti, National Bureau of Standards; January 15, 1948.

SUBSECTIONS

Fort Wayne

"Short-Time Motor Coast Measurements," by E. G. Downie, General Electric Company; November 24, 1947.

"The Technique of Radio Noise Suppression," by S. A. Zimmerman, General Electric Company; November 24, 1947.

Northern New Jersey

"New Developments in the Traveling-Wave Tube," by J. R. Pierce, Bell Telephone Laboratories; October 8, 1947.

"Television Field Strength Measurements in the New York Area, and Problems of Television Shared-Channel Interferences between Cities," by T. T. Goldsmith, Allen B. DuMont Laboratories; December 10, 1947.

STUDENT BRANCH MEETINGS

University of Alberta, I.R.E. Branch

"Magnetic Recording," by J. H. Scrimgeour, Student; January 14, 1948.

University of Arkansas, I.R.E. Branch

"Possibilities for Use of Electronic Control Devices in the Rice Industry," by C. G. Leonard, University of Arkansas; January 7, 1948.

(Continued on page 38A)

ARNOLD

PERMANENT MAGNETS

Depend on them for Uniformly High Quality in every PHYSICAL, MAGNETIC and METALLURGICAL Characteristic

You would find it hard to set a requirement on Arnold magnets that is not already exceeded in our regular production procedure.

All Arnold products are made on a basis of 100% quality-control at *every* step of manufacture. These rigidly maintained standards cover all physical, magnetic and metallurgical characteristics. . . you can place complete confidence in the uniformity and dependability of Arnold Permanent Magnets, and their resultant performance in your assemblies.

Remember, too, that Arnold's service covers all types of permanent magnet materials, any size or shape of unit, and any field of application. Our engineers are at your command—write us direct or ask any Allegheny Ludlum representative.

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MEMO to:

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NO MULTIPLIER STAGES NEEDED FOR CRYSTAL CONTROL DIRECTLY AT FREQUENCIES UP TO 100 MC. SPECIFY BLILEY FOR ACCURACY, STABILITY, QUALITY, AND ADVANCE DESIGN.

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CRYSTALS

BLILEY ELECTRIC COMPANY UNION STATION BUILDING — ERIE, PENNSYLVANIA

STUDENT BRANCH MEETINGS

(Continued from page 36A)

"Applications of Electronics to Agriculture," by P. H. Matisheck, University of Arkansas, January 21, 1948.

Carnegie Institute of Technology, I.R.E.-A.I.E.E.

"Telephone Systems," by L. R; Pakkensen, D. C. Brewer and F. J. Rau, Students Dceember 3, 1947.

"Phototubes," by E. H. Fritz and W.W. Calloway, Students; December 3, 1947.

"Electrical Engineering as a Public Servant," by R. E. Rodger, G. F. Nielsen, and J. F. Rentz, Students; December 3, 1947.

"Individual Topics," by J. Lucas, R. Ketterer, and C. Jacoby, Students; December 10, 1947.

"E.E.—A Public Servant," by W. W. Ege, R. Crago, and W. Douglass, Students; December 10, 1947.

"C.I.T. Automatic Telephone," by J. Neenan, R. Langkamp, and R. Musgrave, Students; December 10, 1947.

"Geiger Counters," by R. J. Heh, C. W. Duffett, and E. Brazon, Students; December 17, 1947.

"Individual Topics," by E. R. Hornbake, H. L. Brenton, and R. N. Frantz, Students; December 17, 1947.

"Transportation—EE Point of View," by H. I. Sherman, F. R. Lee, J. B. Ramsey, and F. L. Pirkheim, Students; December 17, 1947.

"Individual Topics," by C. F. Freund, C. D. Pollis, E. K. Weiss, and E. P. Worgs, Students; January 7, 1948.

"Insulation," by W. G. Gribble, J. H. Cronin, and S. W. Hunt, Students; January 7, 1948.

"Insulation," by H. K. George, V. A. Gibel, E. L. Johnson, and W. C. Tice, Students; January 7, 1948.

"Cathode-Ray Tubes," by J. McCauslin, D. F. Paull, and W. J. Keefer, Students; January 14, 1948.

"Railway Traffic Control," by H. Birnkrant, J. Augustine, and J. Barclay, Students; January 14, 1948.

"Medical Applications of Electrical Engineering," by J. Faigen, F. Dickson, and J. Kostyo, Students; January 14, 1948.

University of Michigan, I.R.E.-A.I.E.E.

"Stroboscopes and High Speed Photography," by K. Adams, General Radio Company; January 13, 1948.

North Carolina State College, I.R.E.

Election of representatives to the North Caroline State College Engineer's Council; January 15, 1948.

Northwestern University of Technological Institute, I.R.E.-A.I.E.E.

Business meeting; January 15, 1948.

Wayne University, I.R.E.-A.I.E.E.

"Television," by L. Spragg, Radio Station W.W.J.; January 13, 1948.

Worcester Polytechnic Institute, I.R.E.-A.I.E.E.

"Electrical Problems in the Early Days of Power Distribution," by G. Hardy, Retired Engineer of the Worcester Electric Light and Power Company; January 6, 1948.

ADC TRANSFORMERS

Fill Super Specifications From Subsonic to Ultrasonic

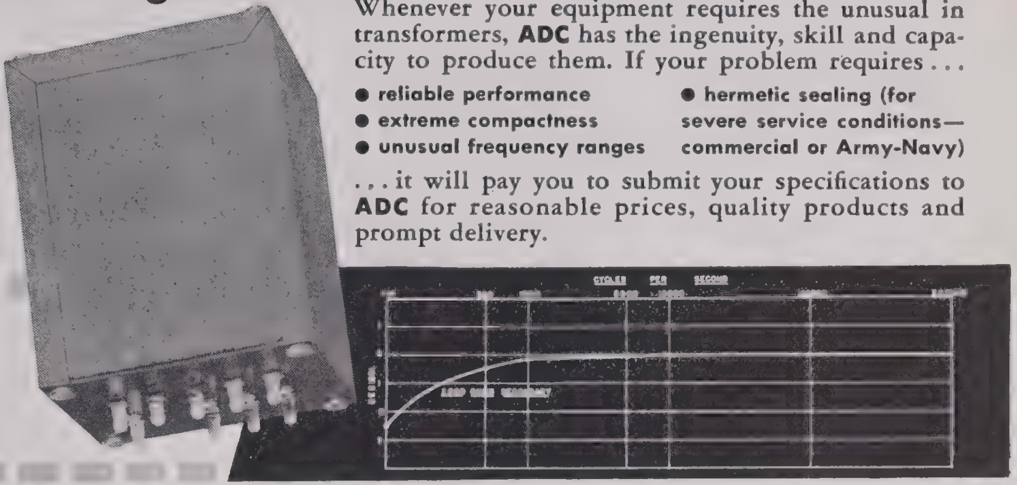
For Ultrasonic Ranges

This **ADC** Transformer is custom-built to couple the output of an amplifier (30 watts) to a transducer. Impedance Ratio is 2500 ohms (4-2A3) to 500/700/1000/1500/2000 ohms. Transformers have been designed at **ADC** to operate up to 3 mc with useful band width in excess of 1:1000.

Whenever your equipment requires the unusual in transformers, **ADC** has the ingenuity, skill and capacity to produce them. If your problem requires . . .

- reliable performance
- extreme compactness
- unusual frequency ranges
- hermetic sealing (for severe service conditions—commercial or Army-Navy)

. . . it will pay you to submit your specifications to **ADC** for reasonable prices, quality products and prompt delivery.



For Audible Ranges

This transformer has no unusual electrical properties, but it was designed for extreme dependability. It is an output from pp 6V6 to line, for voice range only (1 db—150 to 4000 cps). It was ordered from ADC simply because the equipment manufacturer required *unfailing* performance.

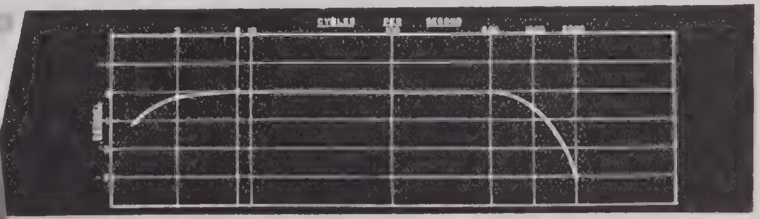
All **ADC** transformers have built-in reliability . . . a feature especially necessary for radio broadcasting, communications, wire recording, telemetering equipment, etc. A slightly higher original cost is more than offset by the dependability and quality of **ADC** design and manufacture.

For Subsonic Ranges

(such as geo-physical work)

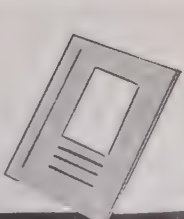
This transformer operates from pp plates (20,000 ohms) to pp grids (320,000 ohms) down to 2 cps. Secondary inductance is over 60,000 henries. It also has tertiary low impedance winding. Hermetically sealed—10 cubic inches.

ADC has designed and made many low frequency transformers—some to operate from frequencies as low as 0.1 cps.



HERE are several charts showing characteristics of unusual transformers developed by ADC engineers. Many transformers have a wide range of requirements shown in the ADC Transformer Catalog. If you do not have your copy—*WRITE TODAY FOR CATALOG NUMBER 46-S*

Send us your special specifications for prompt and able transformer service.



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2-WAY VHF
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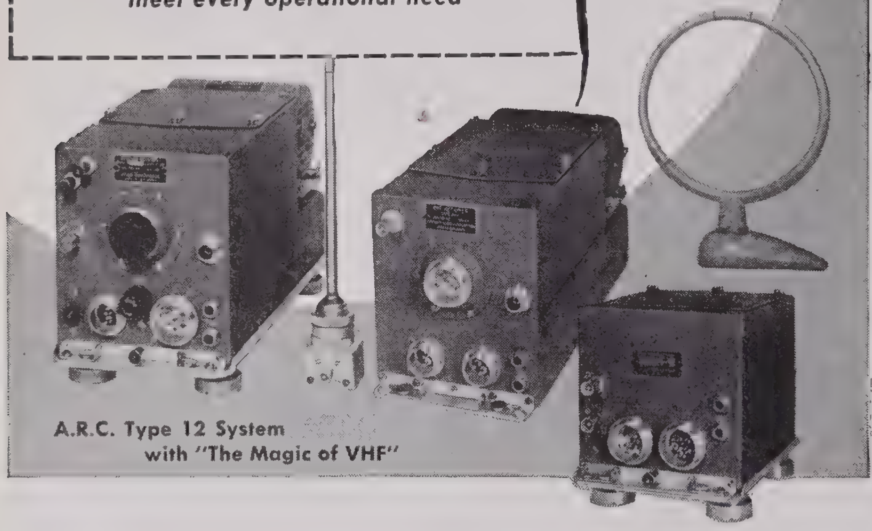

A.R.C. Type 12 System
with "The Magic of VHF"

Aircraft Radio Corporation has engineered a series of Communication and Navigation Systems to cover operational requirements for the 3 or 4 place executive-type aircraft.

THE A.R.C. TYPE 11A meets basic needs by providing for VHF Transmission, LF Range Reception and Rotatable Loop Navigation.

THE A.R.C. TYPE 17 is a 2-way VHF equipment, including a tunable VHF Receiver and a 5-channel, crystal controlled VHF Transmitter.

THE A.R.C. TYPE 12 illustrated combines the advantages of the Type 11A and the Type 17, offering 2-way VHF, together with LF Range Reception and Rotatable Loop Navigation.

• • •

All units of these systems have been Type-Certificated by the CAA for use by scheduled air carriers. Standards of design and manufacture are the highest. For the finest in radio equipment, specify A.R.C.

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National Electronics Lab., Inc.
Alexandria, Virginia

Baker-Eberle Aviation Corp.
Detroit, Michigan

Aeronautical Electronics, Inc.
Raleigh, North Carolina

Pacific Airmotive Corp.
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Indianapolis, Indiana

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DEPENDABLE ELECTRONIC EQUIPMENT SINCE [illegible]

MEMBERSHIP

The following transfers and admissions were approved on February 3, 1948, to be effective as of March 1, 1948:

Transfer to Senior Member

Albersheim, W. J., Bell Telephone Laboratories, Inc., Deal, N. J.
Caldwell, P. G., General Electric Co., Electronic Park, Syracuse, N. Y.
Clark, D. E., 2501 N. Keeler Ave., Chicago, Ill.
Dempster, B., 2008 West Seventh St., Los Angeles, Calif.
Fano, R. M., Massachusetts Institute of Technology, Cambridge, Mass.
Fisher, F. J., 1 Richard Rd., Port Washington, L. I., N. Y.
Grundmann, G. L., 16 Oriental Ave., Westmont, N. J.
Guillemin, E. A., Massachusetts Institute of Technology, Cambridge, Mass.
Hachemeister, C. A., 85 Livingston St., Brooklyn, N. Y.
Hodson, W. G., 524 Hampton Rd., Burbank, Calif.
Johnson, E. O., 285 Merion Ave., Haddonfield, N. J.
Kilheffer, L. D., 804 Buckingham Rd., Dayton, Ohio
Koch, W. R., Victor Division 5-3, RCA Laboratories, Camden, N. J.
Mautner, R. S., 201 West 16 St., New York, N. Y.
Morgan, M. G., Thayer School of Engineering, Dartmouth College, Hanover, N. H.
Palmateer, R. E., Sylvan Heights, Emporium, Pa.
Sanborn, J. W., 15 Morris St., Merchantville, N. J.
Schultz, M. A., 635 Cascade Rd., Pittsburgh, Pa.
Skrivseth, A. G., 203 Rogers Dr., Fenwick Park, Falls Church, Va.
Tanner, R. H., 292 Charles St., Belleville, Ont., Canada
Taylor, H. A., RCA Communications, Inc., Riverhead, L. I., N. Y.
Wicks, D. S., 3895 Rodman S., Washington, D. C.

Admission to Senior Member

Isely, F. C., 3131 Westover Dr., S.E., Washington, D. C.
Kennedy, T. R., Jr., 601 West 112 St., New York, N. Y.
Meyer, R. B. 4702 Brandywine St., N.W., Washington, D. C.
Shaw, V. G., Electricl Engineering Department, Carnegie Institute of Technology, Pittburgh Pa.
Word, J. A., 238 Washington Ave., Chatham, N. J.

Transfer to Member Grade

Beins, J. K., 435 Kenilworth Ave., Toledo, Ohio
Broersma, C. B., c/o Radio-Holland, 562 Keizersgracht, Amsterdam C, Netherlands
Hicken, J., 40 Andrews Ave., Binghamton, N. Y.
Karlson, A. T., Severen Heights, Severna Park, Md.
Kidd, W. E., 585 Turner Ave., Glen Ellyn, Ill.
Kopecky, G. F., 304 E. 77 St., New York, N. Y.
Maron, M., Room 303, YMCA, Passaic, N. J.
Peach, S. E., Baldwyn, Miss.
Robinson, A. J., Jr., 226 W 5 St., Emporium, Pa.
Senn, G. F., 81 Garden Rd., Red Bank, N. J.
Shaw, R. G., 1406 Benton Way, Los Angeles, Calif.
Taylor, G. O., 5244 Arrow Rd., Cincinnati, Ohio
Ward, J. F., London House, Guilford St., W. C. 1, London, England
Williams, G. T., Box 440, Sect. 69, Anchorage, Alaska

(Continued on page 42A)

CORNISH
WIRES
at work
CORNISH WIRE COMPANY, INC.
CORNISH

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WHY ARE CORNISH WIRE PRODUCTS SPECIFIED BY THIS LARGE RADIO MANUFACTURER?

Because their
ENGINEERING DEPARTMENT
values their faithful performance and ability to meet the most exacting demands of insulation resistance and voltage breakdown. . . .

Because their
PRODUCTION DEPARTMENT
discovered after thorough testing that they possess the essential qualities which permit easy pushback or mechanical stripping. . . .

Because their
PURCHASING DEPARTMENT
knows these quality products, backed by dependable service, are always priced as low as such good wires can be made and sold. . . .

made by engineers for engineers

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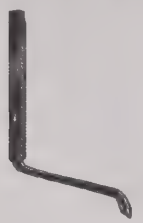
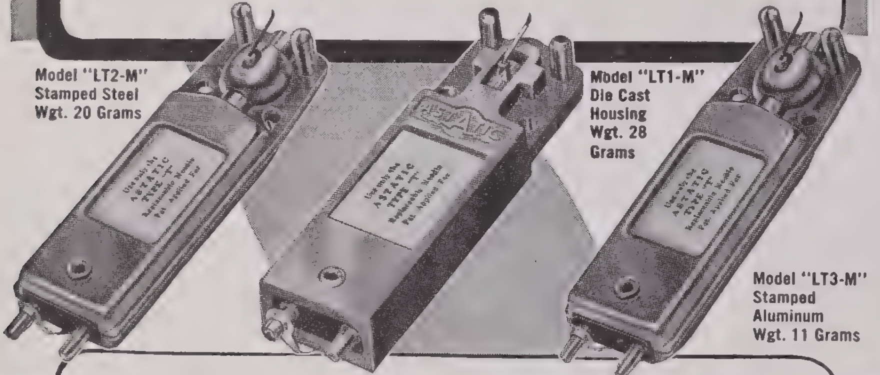
TYPE "T" NEEDLE

with Electro-Formed PRECIOUS METAL TIP

Employed with All Three Models of New "LT" Series Cartridges.



THE DESIGN of this modern, replaceable, carefully engineered stainless steel needle provides a high order of vertical, as well as lateral compliance, with resulting clarity and quiet of phonograph reproduction. Sufficiently large for easy handling, the "T" Needle is inserted in cartridge chuck with the same ease as "old fashioned" needles, and is held fast or released by manipulation of standard set screw.



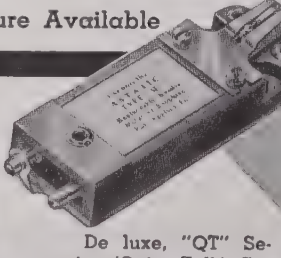
Model "LT2-M"
Stamped Steel
Wgt. 20 Grams

Model "LT1-M"
Die Cast
Housing
Wgt. 28
Grams

Model "LT3-M"
Stamped
Aluminum
Wgt. 11 Grams

BECAUSE of Low Needle Talk, Low Needle Pressure, and Low Price, Astatic's new "LT" Series Cartridges are particularly desirable for new installations in all types of automatic record changers and manually operated phonographs. Now available with stamped steel and aluminum as well as die cast housings, "LT" Cartridges may now be selected in the proper weight to provide optimum needle pressure and pickup inertia characteristics with various types of arms. Output voltage, 1.00 volt average at 1,000 c.p.s. Cutoff frequency, 4,000 c.p.s.

Special Literature Available



De luxe, "QT" Series (Quiet Talk) Crystal Cartridge. Employs matched, replaceable "Q" Needle with sapphire or precious metal tip.

THE Astatic CORPORATION
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO
Astatic Crystal Devices Manufactured under Brush Development Co. patents.

MEMBERSHIP

(Continued from page 40A)

Admission to Member Grade

Arnett, H. D., 18 Danbury St., S.W., Washington, D. C.
Bose, L., 34 Allenby Rd., Calcutta 20, India
Bryant, V. D., 22 High St., Franklin, Ohio
Burke, J. F., 33-17–201 St., Bayside, L. I., N. Y.
Capelli, M. P., 12, Cambridge Dr., Potters Bar, Middx., England
Carlander, A., Ymsenvagen 10, Enskede, Sweden
Carson, R. E., R.F.D., Maple Lane, N. Syracuse, N. Y.
Castilla, A., Calle Evaristo S. Miguel 20, Madrid, Spain
Clute, D. G., 520 Forrer Blvd., Dayton, Ohio
Cramer, R. E., Jr., 500 Jessamine Ave., West Collingswood, N. J.
Eland, R. C. A., 847 E. Chelten Ave., Philadelphia, Pa.
Frey, H. B., Jr., 163 Wade Lane, Oak Ridge, Tenn.
Green, M., North-West Telephone Company, 1955 Wylie St., Vancouver, B. C.
Hope, R. S., Thom & Smith Pty. Ltd., 919–929 Botany Rd., Mascot, N. S. W.
Houghton, E. G., Headquarters Fifteenth Air Force, A3CM, Colorado Springs, Colo.
Kelleher, K. S., 825 Church St., Alexandria, Va.
King, E. F., 3171 Federal Ave., Los Angeles, Calif.
Simler, L. L., 1711 Wait St., Seattle, Wash.
Stovall, J. R., Jr., 500 N. 12 St., Philadelphia, Pa.
Sullivan, E. F., 105 Harrison St., Oak Park, Ill.
Warchol, E. J., 1442 E. 29 St., Tacoma, Wash.
Webb, E. L. R., Electrical Engineering & Radio Division, National Research Council, Sussex St., Ottawa, Ont., Canada

The following admissions to Associate were approved on February 3, 1948, to be effective as of March 1, 1948:

Abernathy, H. D., 4927 Byers, Ft. Worth 7, Tex.
Albert, S. L., 1655 N. Cherokee St., Hollywood 28, Calif.
Aldridge, K. S., Casilla No. 2562, Santiago, Chile, S. A.
Anderson, M. E., 1906 Grismer Ave., Burbank, Calif.
Anderson, R. H., 1400 N. State Pkwy., Chicago 10, Ill.
Augenblick, H. A., Jr., 67 S. Munn Ave., East Orange, N. J.
Austin, F. H., 62-34—60 Ave., Maspeth, L. I., N. Y.
Aveni, G., 1966 S. Normandie Ave., Los Angeles 7, Calif.
Bailey, H. R., 52 Fernwood Ave., Dayton 5, Ohio.
Bates, A. G., c/o Radio Station KFAB, Omaha, Neb.

Bauman, J. P., 1207 Boynton Ave., New York 59 N. Y.
Bird, D. W., 620 E. Bridge St., Blackwell, Okla.
Blankenship, W. B., 2708 Ave. V, Lubbock, Tex.
Boellhoff, L. E., Box 32, Montandon, Pa.
Brennan, R. F., 200 E. 38 St., New York 16, N. Y.
Bricker, L., 2926 W. 24 St., Brooklyn 24, N. Y.
Brougher, R. M., 2912 Robinhood, Houston 5, Tex.
Casen, J. G., 109-01—72 Rd., Forest Hills, L. I., N. Y.
Castle, J. L., 218, Ash-Grove, Heston, Middx., England
Christiansen, T. A., 1929 Morse Ave., Chicago 26, Ill.
Coffin, B. E., Jr., 734 N. 20 St., Philadelphia 30, Pa.
Cooper, P. L., Jr., 980 Thomas Rd., Beaumont, Tex.
Cordella, D. P., 3605 Arthur Ave., Brookfield, Ill.
Coyne, J. M., Jr., 4429½ N. Kedzie Ave., Chicago, Ill.
Crawford, A. L., 1931 N. Tibbs Ave., Indianapolis 22, Ind.

(Continued on page 44A)

DIRECT DRIVE IS BEST FOR YOU

IT GIVES YOU

- ✚ perfect total speed
- ✚ complete absence of adjustments
- ✚ low mechanical noise
- ✚ fast starting
- ✚ minimum maintenance
- ✚ greatest dependability
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- ▬ time spent on adjustments
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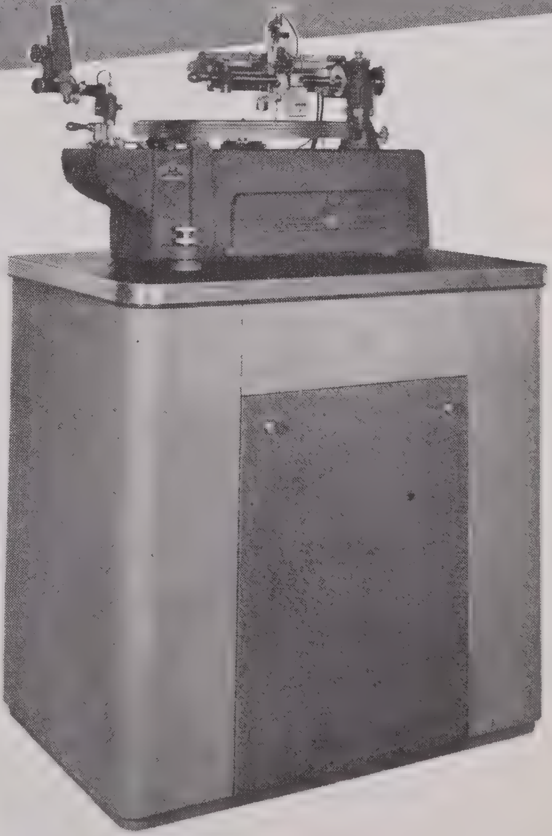
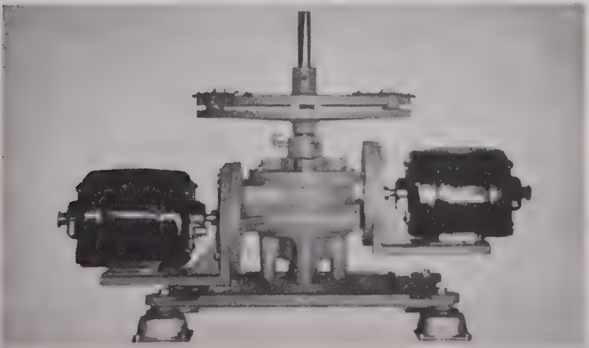
Only Presto Direct Drive has these advantages



THE PRESTO 8D-G RECORDER is the choice of top studios everywhere. This rugged, dependable unit is precision-made for heavy duty. Two separate motors are utilized, one for 33⅓ and one for 78 rpm, employing a dual worm and gear drive direct to center of turntable. You can change speed by switching from one motor to the other *even while in operation* with perfect safety. The mechanical speed shift, frequently a source of trouble with single motor drives, is completely eliminated.

One permanent feed screw incorporates seven cutting pitches for both inside-out and outside-in.

Write today for full specifications and price quotations.



Exclusive direct drive feature of 8D-G utilizes two separate motors. ←

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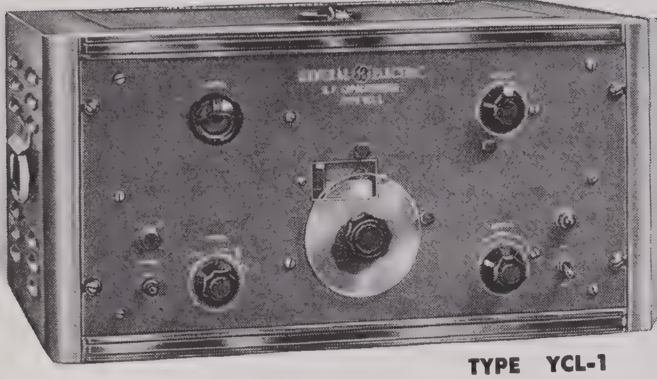
242 West 55th Street, New York 19, N. Y.

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS

RF CAPACITOMETER



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PERMITTING measurements directly at radio frequency of a wide range of capacitance and inductance, the YCL-1 is a most valuable equipment for production, research and industrial laboratories.

Simple in design and self-contained, it can be operated by non-technical personnel. The YCL-1 is a compact and efficient unit which provides accuracy without the use of bridges usually employed for these measurements.

To improve stability of operation, the internal measurement circuits are operated from a built-in electronically regulated power supply.

This General Electric Capacitometer is suitable for portable use, or it may be removed from the cabinet and mounted in a standard nineteen (19) inch relay rack.

CAPACITANCE: 0 to 20,000 micromicrofarads
ACCURACY: ± 1 micromicrofarad or 0.1%, whichever is larger
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For complete information on the YCL-1 Capacitometer and other precision equipments write: *General Electric Company, Electronics Department, Electronics Park, Syracuse, New York.*

GENERAL ELECTRIC

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(Continued from page 42A)

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David, E. E., Jr., 607C, Graduate House, Massachusetts Institute of Technology, Cambridge 39, Mass.
Dooley, L., 1940 E. Tremont Ave., New York 62, N. Y.
Drechsel, R. E., 205 W. Willow, Prospect Hts., Ill.
Everson, C. T., 321—22 St. N.E., Cedar Rapids, Iowa
Fanning, G. B., 527 Aberdeen Ave., Dayton 9, Ohio
Fink, E. A., 5603 Arlington St., Philadelphia 31, Pa.
Fischer, R. E., 4424 N. Clifton Ave., Chicago, Ill.
Foster, W. E., Hazeltine Electronics Corp., 58–25 Little Neck Pkwy., Little Neck, L. I., N. Y.
Friedman, I. B., 5114 S. Kimbark Ave., Chicago 15 Ill.
Fritsch, P. C., 5814 Third Pl., N.W., Washington 11, D. C.
Goldstein, B. M., 1820 Bryant Ave., New York 60, N. Y.
Grant, R. L., 1048 N. Front St., Sunbury, Pa.
Hamilton, D. H., Jr., 1320 Fairmont St., N.W., Washington 9, D. C.
Hatzakortzian, H. T., 424 E. 174 St., New York 57, N. Y.
Heald, E. T., 1313 Third Ave., S.W., Cedar Rapids, Iowa
Henley, E. J., 4208 Ivy St., East Chicago, Ind.
Hiller, F. L., 1288 French Ave., Lakewood, Ohio
Horniman, N. L., 528 Seventh St., Honolulu 57, T. H.
Hostetler, W. E., 5 Winthrop Ter., East Orange, N. J.
Hoyt, W. A., R.F.D. 3, Angola, Ind.
Huckaby, J. H., 67 Waverly Ave., Dayton 5, Ohio
Hymen, C., 686 McDonough St., Brooklyn, N. Y.
Ingram, C., 4746 S. Indiana, Chicago 15, Ill.
Johnson, M. P., 502 Newland Ave., Jamestown, N. Y.
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Kaufmann, W. S., 432 Haddon Ave., Camden, N. J.
Kellerman, R. B., Castle Creek Rd., Castle Creek, N. Y.
Keys, D. D., 4 Monroe, Denver 6, Colo.
Langan, J. E., 985 Amsterdam Ave., New York 25, N. Y.
Laymance, T. D., 1117 Elgin St., Houston 4, Tex.
Leferson, J., 41 Weedhill Ave., Springdale, Conn.
Lord, D. L., 107 N. Inglewood Ave., Inglewood, Calif.
Luecke, M. W., 2113 A West Galena St., Milwaukee 5, Wis.
Martin, L. H., N. Z. Broadcasting Unit, 2 NZEF (JAPAN) B.C.O.F., c/o APO 301, Japan
McBeath, H. M., Jr., 302 Palm St., Abilene, Tex.
McCracken, L. G., Jr., Ordnance Research Laboratory, State College, Pa.
McCusker, R. W., 15 Walker Ave., Pikesville 8, Md.
McKay, G. C., Jr., 602 Reid St., Houston 9, Tex.
Mead, F. S., 4420 Lily Ponds Dr., N.E., Washington 19, D. C.
Mercado, C. R., Box 156, Barceloneta, Puerto Rico
Merchant, V. V., 25–27 Clinton St., Brooklyn 2, N. Y.
Midcalf, W. A., 6217½—11 Ave., Los Angeles 43, Calif.
Miller, C. E., Box 516, Route 7, Mt. Clemens, Mich.
Miller, L. C., 232 E. 81 St., New York 28, N. Y.
Mitchell, J. L., 2802 LaBranch, Apt. 1, Houston 4, Tex.
Moiseve, C. J., 3707 Hope St., Huntington Park, Calif.
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Noil, P. L., Route 10, Green Haven, North Kansas City, Mo.

(Continued on page 46A)

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The *idea* that electronics may be the solution to your problem to create a better product or a more efficient process—is only the start. Making the idea *work* by developing practical, up-to-the-minute applications is where the task really begins.

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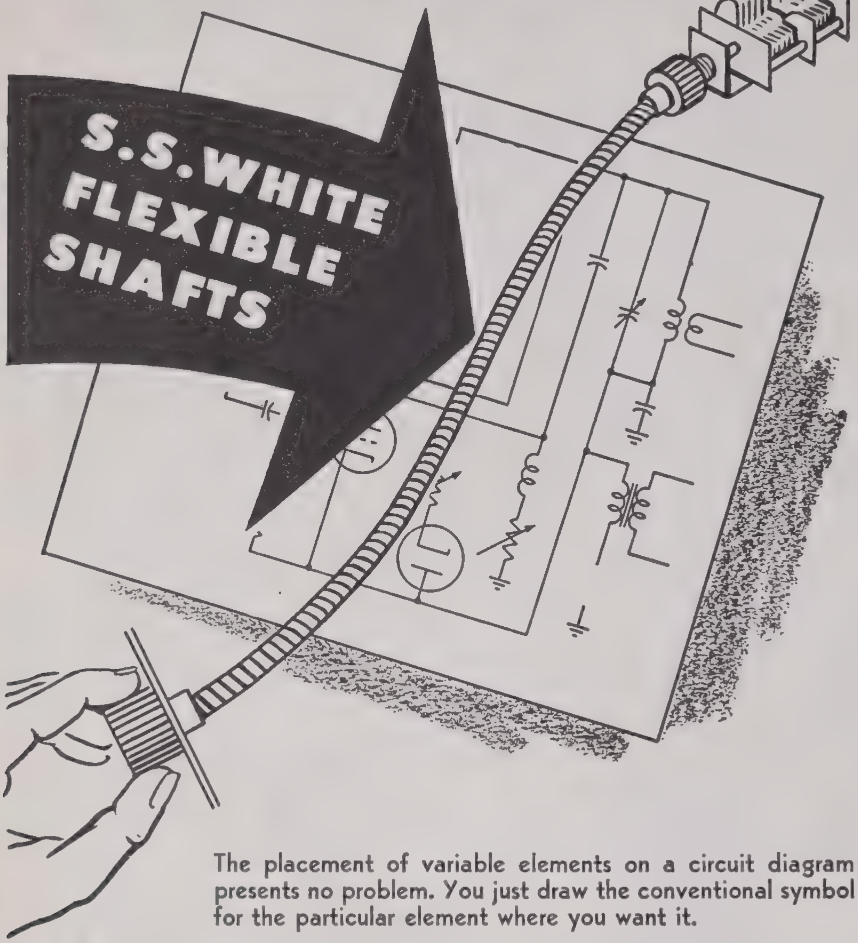
National Union Radio Corporation, 352 Scotland Road Orange, New Jersey

A *"friend in need"*
IN EQUIPMENT DESIGN



The placement of variable elements on a circuit diagram presents no problem. You just draw the conventional symbol for the particular element where you want it.

But in designing the actual equipment it's a different story. The elements must be placed for optimum electrical efficiency and easy assembly and wiring—their controls, for operating convenience and harmonious panel arrangement.

Fortunately, there's a simple way to meet all these requirements—use S.S.White flexible shafts as connecting links between the elements and their controls. From the sketch above you can appreciate that with this arrangement you can place both the elements and the controls anywhere you want them. S.S.White offers shafts engineered just for this service. They're as easy, smooth and sensitive in operation as a direct connection.

GET DETAILS IN THIS FLEXIBLE SHAFT HANDBOOK
260 pages of facts and technical data about flexible shafts and how to apply them. Copy sent free if you write for it on your business letterhead and mention your position.

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MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

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(Continued from page 44A)

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Nelson, J. L., 7402 Bay Pkwy., Brooklyn, N. Y.
Osterberg, E. K., 2151 E. 96 St., Chicago 17, Ill.
Panian, R. M., 31 Gebhart St., Dayton 10, Ohio
Parker, W. L., 3906—50, Des Moines 10, Iowa
Pattison, J. W., Josephine, St. Wingham, Ont., Canada
Pettingill, S. A., 1809 G St. N.W., Apt. 108, Washington, D. C.
Ramamoorti, K. V., 10, Edward Elliots Rd., Mylapore, Madras, India
Reed, J., 88 Hillcrest Rd., Belmont 78, Mass.
Reinheimer, H. J., Jr., 45 Haight Ave., Poughkeepsie, N. Y.
Rew, T. G., 222 Shotwell Park, Syracuse 6, N. Y.
Ritter, G., Aeroporto Federal, Porto Alegre, Rio Grande Do Sul, Brasil
Rotenberg, A. B., 10750 Barman Ave., Culver City, Calif.
Schwartz, M. J., 302 Fifth St., Angola, Ind.
Sharp, H., Box 960, Denver 1, Colo.
Shirley, R. C., 604 Harper Ave., Jenkintown, Pa.
Shook, W. A., 6708—39 S.W., Seattle 6, Wash.
Silverman, H. M., 33 Crawford St., Roxbury 21, Mass.
Slagel, R. J., Jr., 6345 Dante Ave., Chicago 37, Ill.
Sreekantan, B. V. P., Sadvaidyasala Branch, Chickpet, Bangalore, Mysor State, India
Steeb, E. C., Jr., 15 Groveland Ave., Buffalo 14, N. Y.
Stormer, W. J., 1223 F St., N.E., Washington 2, D. C.
Stotler, D. E., 7034 Quince, Houston 17, Tex.
Sudia, A. T., 113 Shaw St., Garfield, N. J.
Trapp, J. A., Electrical Engineering Department, Iowa State College, Ames, Iowa
Uphoff, R. L., 812 Park Ave., Plainfield, N. J.
Veit, F., 78-08—75 St., Brooklyn 27, N. Y.
Viles, F. L., Box 1005, Route 5, Vancouver, Wash.
Volk, N., 32 E. Hill St., Baltimore 30, Md.
Walker, C. E., 165 Fountain Ave., Glendale, Ohio
Walkup, J. F., 7742 Westover Rd., Overland Park, Kan.
Ward, W. P., 1881 Cornelia St., Ridgewood, Brooklyn 27, N. Y.
Weagel, K. D., 30 N. Ogden Ave., Chicago 7, Ill.
Webster, W. M., 22 E. Stanworth Dr., Princeton, N. J.
Weeks, A. D., 818 N. Second St., Alhambra, Calif.
White, L. B., 4803 Arvilla Lane, Houston, Tex.
Whittier, M. L., 43-G. Jones Dr., Bremerton, Wash.
Willhite, G. B., 834 Arlington St., Houston 7, Tex.
Woodbrey, C. S., 18 Ridge Rd., Farmingdale, L. I., N. Y.
Woody, F., 4340 Kenmore, Apt. 22, Chicago 13, Ill.

ERRATUM

The following membership was erroneously listed and should read as follows:

Admission to Senior Member, effective as of February 1, 1948, Umpleby, K. F., Research Department-Bendix Radio Corporation, Baltimore, Md.

News—New Products

(Continued from page 26A)

New Terminal Block

A new feed-through terminal block which meets the need for subpanel and chassis construction with combination screw and soldered terminals has been developed by the **Curtis Development and Manufacturing Co.,** 1 North Crawford Ave., Chicago 24, Ill., which has its factory at Milwaukee 10, Wis. This new type of feed-through terminal block has ample clearance and leakage distances for use in circuits carrying up to 300 volts at 20 amperes.

(Continued on page 48A)

MEASURE SONIC FREQUENCIES . . .

INSTANTLY . . . ACCURATELY . . . VISUALLY

WITH *Stroboconn*

Used effectively in industrial laboratories for checking the speed of rotating objects and for calibrating or checking tachometers, measuring natural frequencies, and calibrating oscillators, impulse generators and similar equipment. With the Stroboconn, you can speed up the job with full assurance of accurate results.

A Notable Achievement in Sonic Research

The Stroboconn is essentially a logarithmic frequency meter of the Stroboscopic type, having an accuracy of frequency determination of 0.05%, in the continuous range of 32 to 4070 cycles per second. Ultra-sonic frequencies may be reduced to Stroboconn range by use of a frequency divider. The logarithmic scale is particularly advantageous in measuring ratios of two frequencies, with or without regard to the actual frequencies involved.

In use, the quantity to be measured is converted into an audio signal, amplified and fed to a discharge tube that produces flashes of light at the audio rate involved. A dial reading indicates the frequency of the input signal. Send for *free* folder and further information concerning the Stroboconn's adaptability to your particular problem.

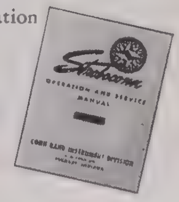
PROVED PERFORMANCE

Among Stroboconn users are Harvard University, Bell Aircraft Corp., and Hamilton Standard Propellers. During the War, this instrument was used as a standard for checking equipment in the Army Air Forces Power Plant Laboratory, at Wright Field.

★ ★ ★

Send for Free Folder

Gives more complete information about operation and application of this amazing precision instrument. No obligation.



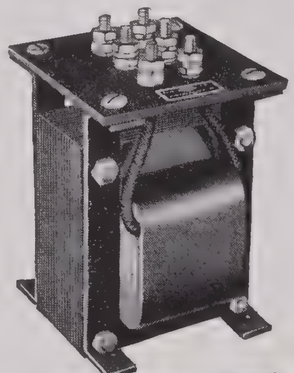
CONN BAND INSTRUMENT DIVISION
C. G. CONN LTD., DEPT 313
ELKHART, INDIANA

Stroboconn

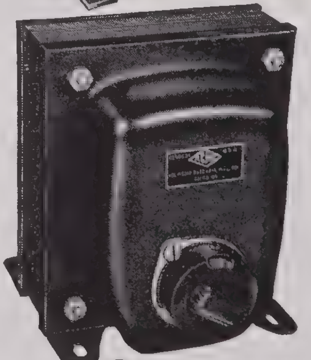
DO YOU NEED TRANSFORMERS with TAP CHANGERS?

Instead of spending time and money to develop your own special method of voltage adjustment, make use of these Acme Electric engineered transformer designs with time-proven, tap-changing features.

These general physical designs can be engineered to exactly the electrical characteristics required for your product—using standard parts. Economy demonstrated before your eyes.



Mounting type 121, provided with tap-changing panel with windings to provide any connections needed. Available in ratings from 35 to 2500 VA.



Mounting type 141, with windings enclosed in end bells. Primary tap changer on front indicating ratings. Available in ratings from 35 to 500 VA.

Mounting type 150, lead holes on bottom or side of half shell. Primary tap changer on top. Available in ratings from 35 to 500 VA.

For further information write for Bulletin 168.

ACME ELECTRIC CORPORATION
44 WATER ST. CUBA, N. Y.

Acme ACME Electric
TRANSFORMERS

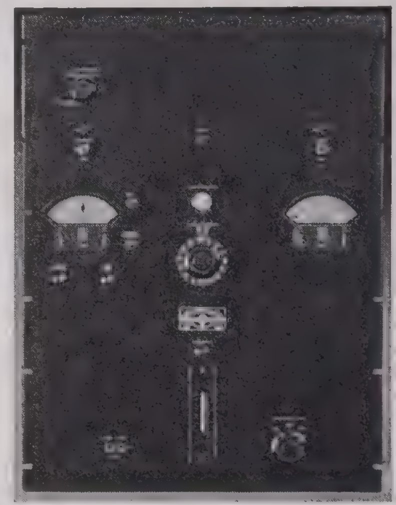
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 46A)

New F.M. Monitor

The new f.m. monitor, manufactured by **General Radio Co.,** 275 Massachusetts Ave., Cambridge 39, Mass., is designed for monitoring f.m. broadcast and television audio transmitters. It provides a continuous indication of center frequency; a meter indication of percentage modulation, positive, negative, or peak-to-peak; and a lamp indication of peaks in excess of a predetermined percentage.



The stability of center-frequency indication is comparable with that obtained on a.m. monitors in the standard broadcast band, so that no calibration checks need to be made during the operating day, and hence a remote indicator can be used at the transmitter engineer's desk.

The Monitor uses a counter-type discriminator which not only permits the use of a low intermediate frequency, with a resulting high degree of stability, but also because of its inherent linearity keeps distortion at a minimum. Two audio output systems are provided, one for measuring distortion and noise with the Type 1932-A Distortion and Noise Meter, and the other for audio monitoring. Inherent distortion is less than 0.2 per cent and distortions as low as 0.5 per cent can be measured accurately, according to the manufacturer. The noise level is at least 75 db below 100 per cent modulation.

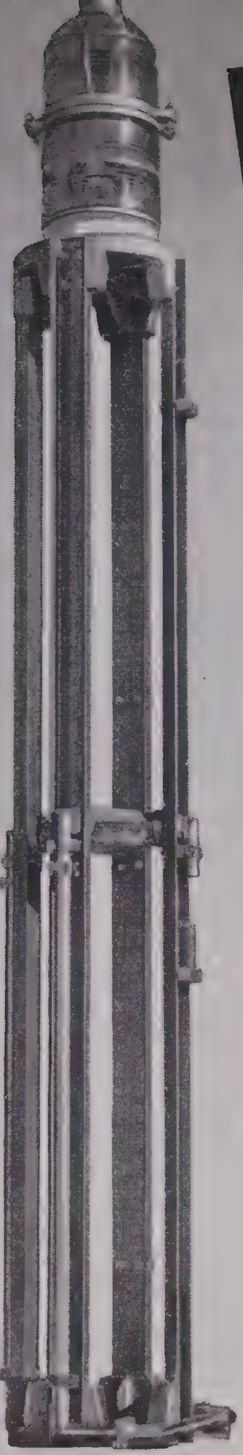
The panel is 19 by 26 inches, and the depth behind the panel is 13½ inches overall. The instrument weighs 88 pounds.

(Continued on page 65A)

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

The new

RAYTHEON FM ANTENNA



Tops everything for

- **HIGHEST GAIN.** 2.15 for 10′ 6″, single section* compared with nearest competitive gain of 1.5 for 13′ 6″ section.
- **LOWEST COST.** Less than anything approaching its performance and features.
- **EASY TO INSTALL.** Shipped pre-tuned to your frequency — no field adjustments — only one, simple, co-ax feed connection.
- **PERFECT RADIATION.** New "waveguide" radiation principle for perfect circular radiation — horizontal polarization.
- **NO ICING PROBLEM.** Feed elements completely enclosed by weather-proof radome — no de-icing equipment needed.
- **FULL POWER.** A single section will handle 10KW — available in single, double and four-section assemblies.
- **NO OBSOLESCENCE.** Add new sections for increased gain.
- **LOW WIND LOADING.** Simple, open, self-supporting structure — no protruding elements — offers lowest wind resistance.
- **PLUS MANY OTHER IMPORTANT FEATURES** The new Raytheon Type RFW Antenna is *your* idea . . . built to answer countless requests for a better, less expensive, trouble-free FM antenna. It's available *now!* Get the whole story from your Raytheon representative today.

*RFW — A (88 — 97 MC.) — single section 11′ 6″.
RFW — B (97 — 108 MC.) — single section 10′ 6″.

RAYTHEON
Excellence in Electronics

LOOK TO RAYTHEON FOR ALL YOUR NEEDS

Transmitters, Speech Input Equipment, Antenna, Antenna Network, Tower, Frequency and Modulation Monitors, Voltage Stabilizers, Transcription Players and Pickups, Recorders, Microphones, Speakers, Relays, Coaxial Cable, Replacement Tubes.

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ELECTRONIC ENGINEERS WANTED

Engineers experienced in the development and design of electronic equipment.

Present staff of more than 100 engineers being increased. Opportunity for advancement with long-established and growing company. Laboratories and plant situated in pleasant, open surroundings on Long Island within half hour of New York City.

Write details of education and experience (all inquiries confidential) to

Director of Engineering Personnel

HAZELTINE
ELECTRONICS
CORPORATION
Little Neck, L.I., N.Y.

WANTED PHYSICISTS ENGINEERS

Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or development experience on radio communications systems, electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.

WRITE FULL DETAILS

TO

EMPLOYMENT SECTION

SPERRY
GYROSCOPE
COMPANY, INC.
Marcus Ave. & Lakeville Rd.
Lake Success, L.I.

Engineers—Electronic

Senior and Junior, outstanding opportunity, small growing company. Forward complete resumés giving education, experience and salary requirements to

Box 509
The Institute of Radio Engineers
1 East 79th St., New York 21, N.Y.

ENGLISH-SPEAKING ENGINEERS wanted by Radio Corporation of America

- Experienced electronic engineers required for design and development work in radio, radar, television and allied electronic fields. Positions for both electrical and mechanical engineers, in Philadelphia area and elsewhere.

We do not wish to deplete the staffs of established foreign laboratories, but shall welcome inquiries from qualified engineers who are about to reside in the United States.

Write to Chief Engineer, Radio Corporation of America, RCA Victor Division, Camden, New Jersey, U.S.A.

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

ENGINEERS

Microwave engineers wanted. Laboratory experience essential (Industry or Government). Communications for video. Permanent. Salary relatively high. You are invited to visit our modern plant and talk to our engineers, or write us your job history and education. Motorola, Inc., 4545 W. Augusta Blvd., Chicago 51, Illinois, Att: Mr. E. Dyke.

SCIENTISTS AND ENGINEERS

Wanted for research and advanced development work in the fields of microwaves, radar circuits, gyroscope systems, servomechanisms and general electronics. Scientific or engineering degrees required. Salary commensurate with experience and ability. Inquiries should be directed to Manager, Engineering Personnel, Bell Aircraft Corporation, Buffalo 5, N.Y.

ENGINEERS AND PHYSICISTS

Several openings available in radar and in medium and ultra high frequency design work. Positions are in the Engineering Department of a progressive middle western manufacturer. Physicists will find unusual opportunities in the Research Department. A degree from a recognized engineering college is essential as well as good industrial experience. Address reply to Collins Radio Company, Cedar Rapids, Iowa.

ELECTRICAL ENGINEERS AND PHYSICISTS

An expanding program of teaching and research has created opportunities as instructor, assistant professor and associate professor level in a large mid-eastern college. Your inquiries are invited. Box 500.

SALES ENGINEER

Manufacturer's representative wants assistant to cover Connecticut territory. Must have sales experience and knowledge of electronic components. Salary, expense allowance and commission. Please furnish complete background information. Box 501.

MECHANICAL ENGINEER

Mechanical engineer to prepare technical manuscripts covering certain operations of the Los Alamos Laboratory. Applicant must have a B.S. degree in mechanical engineering and considerable experience in engineering and technical writing. Interested persons may write directly to Employment Director, P.O. Box 1663, Los Alamos, New Mexico.

(Continued on page 54A)

SMALLER, LIGHTER

"EVEREADY"

"A-B" BATTERY

for more compact portables!

Will outlast any other battery pack of its size!

SPECIFICATIONS:

Voltage:
"A"-9, tapped at 7½,
"B"-90.

Size:
9 7/32" x 2 23/32" x 4 5/16".

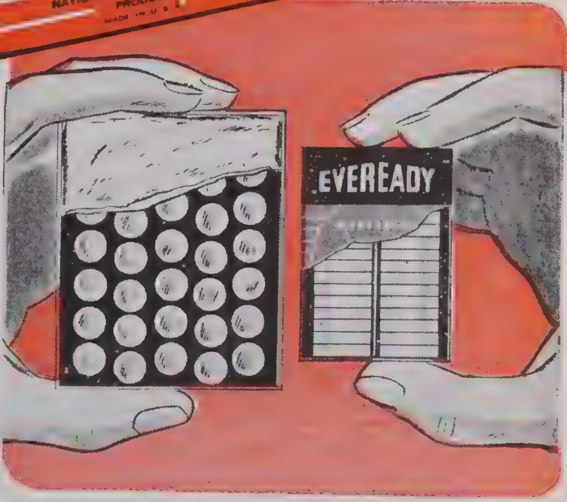
Net weight:
4 lbs. 15 ozs.

No. 753
No. 753
EVEREADY
TRADE-MARK
MINI-MAX
"A-B"
RADIO BATTERY PACK
FOR PORTABLE RECEIVERS
A NATIONAL CARBON COMPANY PRODUCT
MADE IN U.S.A.

The No. 753 "Eveready" combination "A-B" 90-volt battery pack provides plenty of power for the more compact "pick-up" portable radios. It will last longer than any other "A-B" pack of comparable size.

This longer life is the result of the exclusive flat-cell principle found only in "Eveready" batteries.

It will pay you, in designing your new portables, to take advantage of this powerful, lighter-weight, smaller "Eveready" battery pack. For more details, consult National Carbon Company, Inc.



- Ordinary battery (*left*) is made of *round* cells and wasted space! "Eveready" battery (*right*) is made of *flat* cells—*no space between them* wasted by air, pitch, or cardboard!

EVEREADY
TRADE-MARK
MINI-MAX
RADIO BATTERIES

The registered trade-marks "Eveready" and "Mini-Max"
distinguish products of

NATIONAL CARBON COMPANY, INC.

30 EAST 42nd STREET, NEW YORK 17, N. Y.

Unit of Union Carbide and Carbon Corporation

UCC

Positions in APPLIED RESEARCH . . . .
INSTRUMENT DESIGN . . . . . .
ELECTRONIC DEVELOPMENT .

are available to Physicists and EE's with Bachelor, Master or Ph.D. degrees. Assignments are in radar, transmitters, receivers, antennas, electronic instruments, and field intensity measurements.

Scientists now on our staff are interested not only in developing new devices, but also in exploring fully the principles behind them. These men, experts in their fields, have helped evolve an organization conducive to success in both undertakings.

Employment at this Laboratory provides:
- Opportunity for professional advancement.
- Optional insurance and pension plans.
- Advantageous location for personal living, with ready access to engineering school graduate work.
- Recreational programs.

Visit us at the Commodore Hotel during the IRE convention; or phone Garden City 6880; or write to: PERSONNEL DEPARTMENT,

Airborne Instruments Laboratory
INCORPORATED
160 OLD COUNTRY ROAD · MINEOLA, N.Y.

ENGINEERS . . . We have immediate openings for electrical and mechanical engineers experienced in the design, development, and research of the following:

TRANSMITTERS	SCIENTIFIC INSTRUMENTS
RECEIVERS	TUBES
RADAR	RECORDING INSTRUMENTS
MOBILE COMMUNICATIONS EQUIPMENT	TELEVISION
ALLIED ELECTRONIC FIELDS	AVIATION EQUIPMENT

Address detailed replies to National Recruiting Division, RCA Victor, Camden 4, N. J.

RADIO CORPORATION of AMERICA

POSITIONS OPEN

(Continued from page 50A)

ACOUSTICAL ENGINEER

Acoustical engineer wanted with experience in microphone or pickup design. Must know mechanical and acoustical circuits. Write details of experience and education to Engineering Department, Electro-Voice, Inc., Buchanan, Michigan.

ENGINEERS

(1) Mid-western manufacturer has opening for electronic engineer with background in electronic circuit design and instrumentation. Experience with pulse technique, servo-systems or telemetering procedures is desirable. Unlimited opportunity in a specialized field. Submit complete résumé and salary desired.

(2) Electrical designer with drafting experience and knowledge of mechanical layout. Experience in design of automatic test equipment desirable. State salary expected.

(3) Electro-mechanical draftsman. Must know symbols and be able to make composite layouts of electrical subassemblies. State salary desired. Write Box 502.

(Continued on page 56A)

LOS ALAMOS SCIENTIFIC LABORATORY

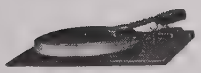
Has present need for physicists of Ph.D. grade with research and development experience in various phases of nuclear physics, electronics, optics, and physical chemistry. Both field and laboratory experimentation involved, depending on interests and capabilities. Also included is design and development of special laboratory electronic, mechanical and optical apparatus. Interviews at project expense can be arranged for qualified applicants.

Write direct to Employment Director, P.O. Box 1663, Los Alamos, New Mexico for further particulars, giving brief résumé of education and experience.

PROFESSIONAL PERFORMANCE—that keeps the original sound alive!

Ride 'em without Rumble!

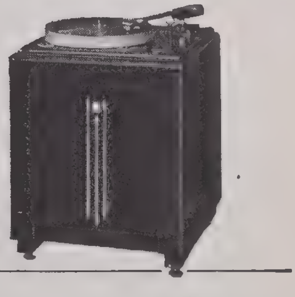
—on a turntable free of vibration



The pounding of hooves may be sweet music to the ears of a race jockey. But to a disc jockey—whose program's success depends upon the undistorted high fidelity of his transcriptions—any extraneous mechanical noise leaves his listeners at the starting post. They just won't ride with him!

Fairchild engineers have succeeded in eliminating the last bit of extraneous mechanical noise — in the newly redesigned Unit 524 Transcription Turntable. Turntable noise, rumble and vibration are non-existent because of the unique method of mounting the drive — at the bottom of the cabinet . . . the use of a specially designed rubber coupling to connect the drive and synchronous motor which are spring-mounted and precision-aligned in a single heavy casting . . . the use of sound-stopping mechanical filters on the hollow drive shaft to reduce the transmission of vibration from the drive mechanism to the turntable . . . and the use of a heavy, webbed cast aluminum turntable mount at the top of the cabinet.

In addition to freedom from rumble, Fairchild offers you a wider frequency range and lower distortion content with its Unit 542 Lateral Dynamic Pickup, with a stylus mounting that allows the tip to follow the minute indentations engraved in the groove from 30 to 10,000 cycles and beyond, with a minimum of distortion. Want more details about sound equipment that really keeps the original sound alive? Address: 88-06 Van Wyck Boulevard, Jamaica 1, New York.



Transcription Turntables
Studio Recorders
Magnetic Cutterheads
Portable Recorders
Lateral Dynamic Pickups
Unitized Amplifiers

AM SOUND EQUIPMENT FM

Fairchild CAMERA AND INSTRUMENT CORPORATION

Chance of a Lifetime

for

Electronics Engineers
Physicists
Mathematicians

DOES your present job offer you full, unlimited opportunity to go ahead NOW? If not, here's your chance to move ahead. We have a number of excellent positions for men who want to demonstrate their ability and build a real future. Our research projects include—jet propulsion, guided missiles, supersonics, electronics, materials and alloys, military planes and commercial transports. Our central location, excellent facilities, good working conditions and past record are nationally recognized. Here is your chance to build a lifetime career with a company holding more than $100,000,000 in orders.

Write now, outlining your experience and your plans. Professional Employment Section, The Glenn L. Martin Company, Baltimore 3, Maryland.

Men are especially needed to do original work in the following fields:

R. F. Components, Wave Guides, etc.

Pulse Techniques, Precision Timing, Indicator Circuitry, I. F. Amplifiers, AFC, etc.

Microwave Antennae

Servos and Computers

POSITIONS OPEN

(Continued from page 54A)

ELECTRONIC ENGINEERS

Opportunity for experienced electronic engineers in established and expanding development company. We design and produce electronic controls and computor equipment. Contact Electronic Associates, Inc., Long Branch, New Jersey. Telephone: L.B. 6-1100. Att.: Mr. Arthur L. Adamson.

DEVELOPMENT ENGINEER

Development engineer needed to design and develop electronic instruments for research work. Excellent opportunity for a man with a degree and practical experience in test equipment construction. Write, giving full details of education and experience to Personnel Office, University of Chicago, 956 E. 58 Street, Chicago 37, Illinois.

INSTRUCTOR

Southwestern church-related University. Man with Master's degree and teaching experience to teach radio theory and electronics. Salary range: $3,000-$3,300 for 9 months depending upon experience. Box 505.

(Continued on page 58A)

PHYSICISTS
and
ELECTRONIC ENGINEERS
Needed for
RESEARCH AND DEVELOPMENT LABORATORY
Interesting opportunities for qualified

GRADUATE ENGINEERS
with
ELECTRONIC RESEARCH, DESIGN
and/or
development experience.

Please furnish complete résumé of education, experience and salary expected.

Personnel Manager

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION

Baltimore 4, Maryland

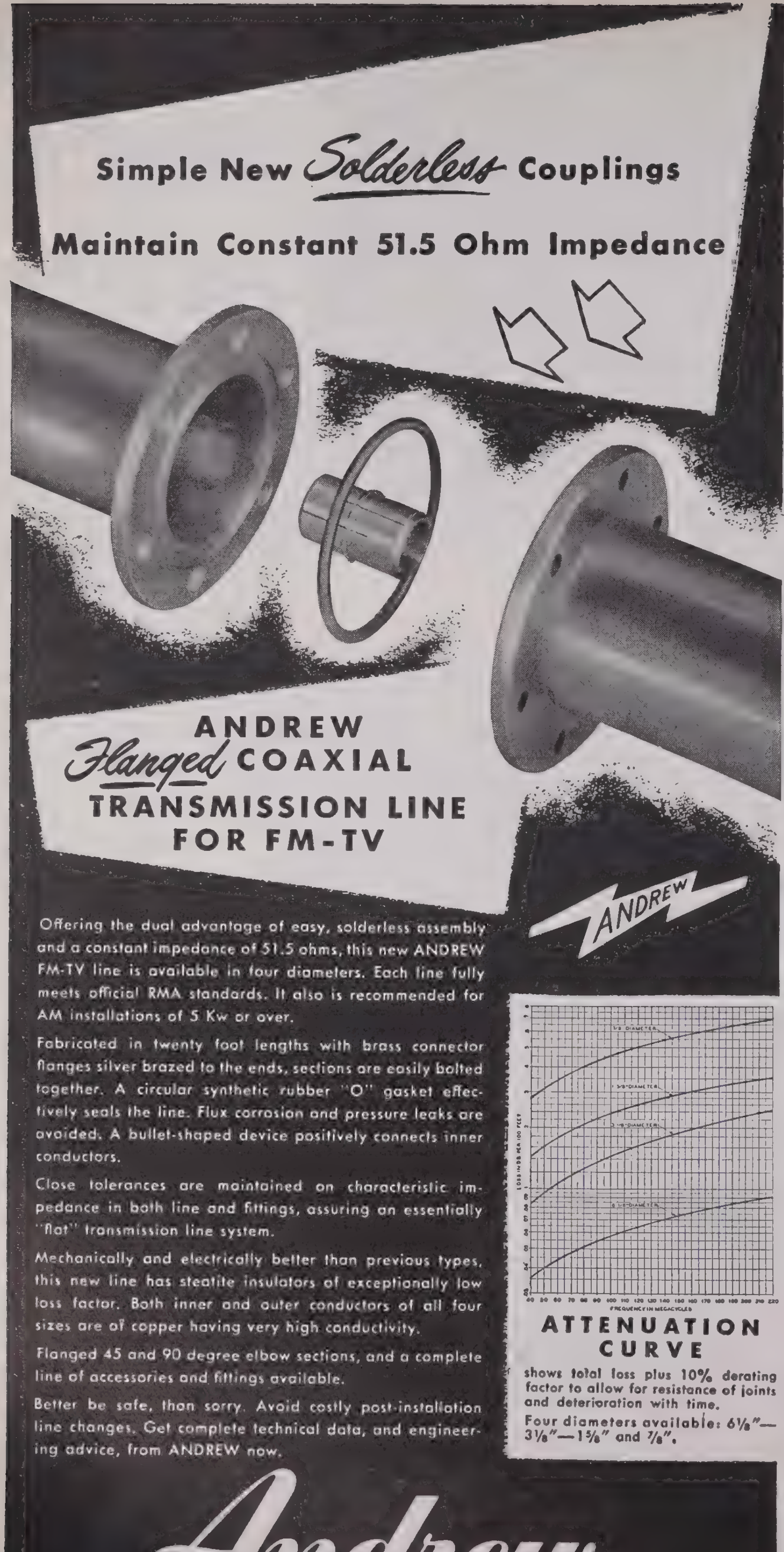
ON DISPLAY
AT THE
IRE SHOW
CONTAINING NON-CORROSIVE FLUX
ERSIN
Multicore
THREE CORE
SOLDER
MULTICORE SOLDERS LTD.
MELLIER HOUSE
ALBEMARLE ST.
LONDON. W.1.

Our claim is a simple one. We believe that Ersin Multicore is the finest cored solder in the world. If you are not already familiar with our product, we believe it can be of special assistance to you in your soldering processes whether you are manufacturing 10,000 radio receivers or repairing one • Ersin Multicore is solder in the form of a wire containing 3 cores of non-corrosive Ersin Flux • You get a guarantee of flux continuity. The Multicore construction gives you extra-rapid melting. Combined with a super active Ersin Flux—**Exclusive with Multicore**—you enjoy a speedy and consistently high standard of precision soldering • Available in 5 alloys and 9 gauges. Please write for detailed technical information and samples.

Address U.S.A. and Canadian
inquiries to:
British Industries Corp.
315 Broadway, New York 7, N.Y.
Cables: Britind, New York

ERSIN MULTICORE

Regarding other territories:
MULTICORE SOLDERS LTD.
Mellier House, Albemarle St.,
London, W.1, England
Cables: Dustickon, Piccy, London.



Simple New *Solderless* Couplings

Maintain Constant 51.5 Ohm Impedance

ANDREW
Flanged COAXIAL
TRANSMISSION LINE
FOR FM-TV

Offering the dual advantage of easy, solderless assembly and a constant impedance of 51.5 ohms, this new ANDREW FM-TV line is available in four diameters. Each line fully meets official RMA standards. It also is recommended for AM installations of 5 Kw or over.

Fabricated in twenty foot lengths with brass connector flanges silver brazed to the ends, sections are easily bolted together. A circular synthetic rubber "O" gasket effectively seals the line. Flux corrosion and pressure leaks are avoided. A bullet-shaped device positively connects inner conductors.

Close tolerances are maintained on characteristic impedance in both line and fittings, assuring an essentially "flat" transmission line system.

Mechanically and electrically better than previous types, this new line has steatite insulators of exceptionally low loss factor. Both inner and outer conductors of all four sizes are of copper having very high conductivity.

Flanged 45 and 90 degree elbow sections, and a complete line of accessories and fittings available.

Better be safe, than sorry. Avoid costly post-installation line changes. Get complete technical data, and engineering advice, from ANDREW now.

ATTENUATION CURVE

shows total loss plus 10% derating factor to allow for resistance of joints and deterioration with time.

Four diameters available: 6⅛"—3⅛"—1⅝" and ⅞".

Andrew
CORPORATION
363 EAST 75th STREET · CHICAGO 19

Pioneer Specialists in the Manufacture of a Complete Line of Antenna Equipment

POSITIONS OPEN

(Continued from page 56A)

ELECTRONICS ENGINEER

Electronics engineer for carrier telephone work by a St. Louis manufacturer of public utility equipment. Several positions open. Box 506.

SENIOR ENGINEER

Fine opportunity with a large midwestern radio corporation. Must have a minimum of three years' experience in loudspeaker design and materials used in manufacturing. College education in electronics or equivalent. In replying state age, education, experience and salary requirements. Box 507.

ENGINEERS

Technical college in northern New York is adding several staff members to the Department of Electrical Engineering. Men with some experience in research or design and development in communications—electronics or physics are preferred. Salary and rank will be commensurate with training and experience. Box 508.

ELECTRONICS ENGINEER

Graduate electronics engineer, experienced in the application of electronic controls on air born equipment. Some production and development experience is essential. In reply, give training, experience and other pertinent facts. Box 510.

* * *

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ENGINEER

M.S.E.E. in 1947. Single. Age 28. Two years' electronic work in the Navy. Two years' teaching. B.S.E.E. in 1942. Prefer development or research. Box 133W.

(Continued on page 60A)

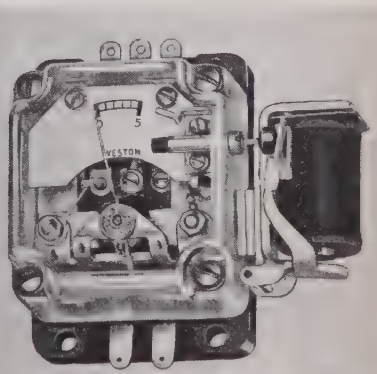
TINY...BUT SO SENSITIVE...SO TOUGH!
MV
25 0 25
WESTON

This **WESTON** [MODEL 813] **Sensitrol Relay*

- **provides positive control on 2 microamperes**
- **handles up to 50 milliamperes at 120 volts AC or DC**
- **resists extreme shock and vibration**

Here is a sensitive relay whose unique characteristics stir the imagination... suggesting to design engineers vast possibilities for *new* product development, and for simplification and improvement of existing products. To assist in their proper application, consult our representatives, or write... WESTON Electrical Instrument Corporation, 589 Frelinghuysen Ave., Newark 5, New Jersey.

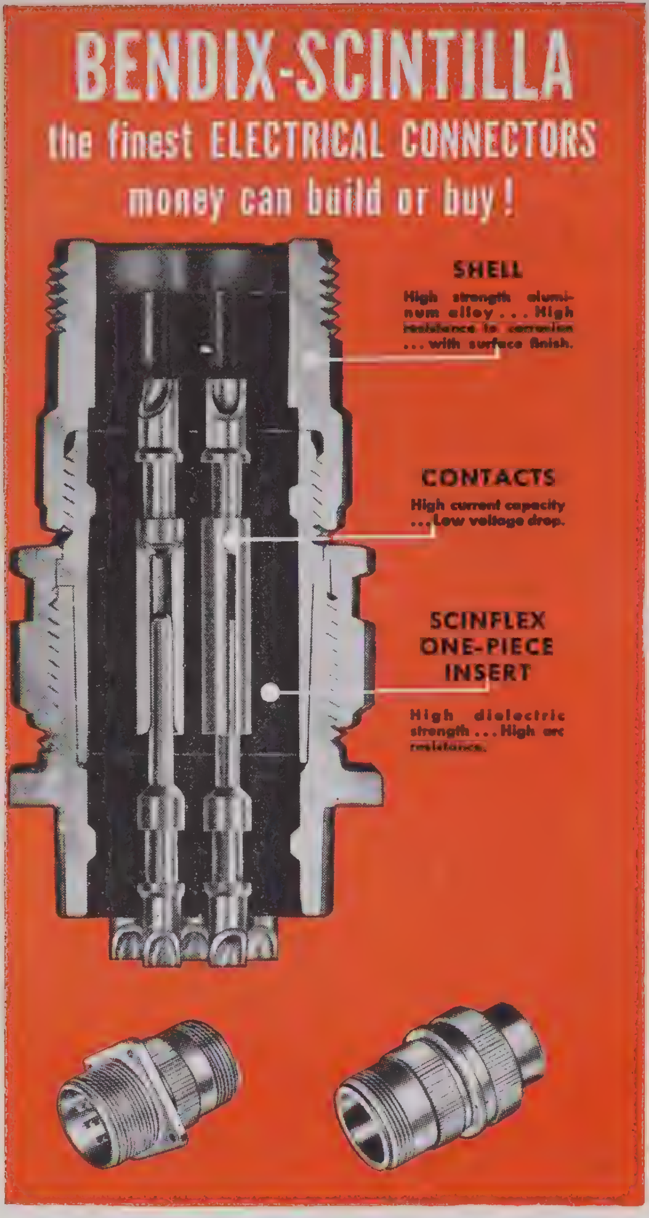
**SENSITROL—A registered trade-mark designating the contact-making instruments and relays, as manufactured exclusively by the Weston Electrical Instrument Corporation.*



Solenoid reset type (illustrated directly above) or manual reset types available.

WESTON *Instruments*

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES · MERIDEN · MINNEAPOLIS · NEWARK · NEW ORLEANS · NEW YORK · PHILADELPHIA · PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS · SYRACUSE · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.



BENDIX-SCINTILLA
the finest ELECTRICAL CONNECTORS
money can build or buy!
SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High arc resistance.

AND THE SECRET IS SCINFLEX!

Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—an exclusive feature that means lower maintenance cost and better performance.

*REG. U.S. PAT. OFF.

Write our Sales Department for detailed information.

• Moisture-proof, Pressure-tight • Radio Quiet • Single-piece Inserts • Vibration-proof • Light Weight • High Arc Resistance • Easy Assembly and Disassembly • Less parts than any other Connector

Available in all Standard A.N. Contact Configurations

BENDIX SCINTILLA
SCINTILLA MAGNETO
SIDNEY, N. Y.
DIVISION OF
Bendix
AVIATION CORPORATION

Positions Wanted

(Continued from page 58A)

ADMINISTRATIVE ENGINEER

Relieve top level engineering personnel of technical-administrative duties; 5 years responsible experience National Bureau of Standards; project coordination and planning; new systems development; preparation of technical reports, engineering specifications; electronics procurement; technical representative for outside contacts. Age 27. Intelligent, initiative, ability to secure cooperation of others. Box 134W.

ENGINEER

B.E.E. New York University, 1944. Age 24. Single. Ex-communications officer. Desires work as executive's assistant or sales engineering in the radio-electronics field. Interesting work and opportunity for advancement primary importance. Box 135W.

JUNIOR ENGINEER

B.S.E.E. Carnegie Tech. in September 1947. Age 22. Single. 2 years' Navy electronics experience. Desires position in electronics research design or development. Box 139W.

JUNIOR ENGINEER

Graduate of RCA Institutes. Age 27. Married. Desires work in radio, electronics, television production or development anywhere in U. S. 3 years' radio work in Army. Box 140W.

SALES ENGINEER

Sales Engineer: Broadcast engineer, past three years as Chief Engineer of local station. Interested in entering sales field as an engineer with an established manufacturer of broadcast equipment. Family man. 28 years old; prefer southwest territory. Box 144W.

ELECTRICAL ENGINEER

Electrical Engineer. Age 27. Single. B.E.E. 1949. 5 years' experience in testing, development, drafting and maintenance of electrical equipment. Wants New York sales position with electrical or electronic equipment manufacturer. Sales training must be part of long range program. Write Box 145W.

ELECTRICAL ENGINEER

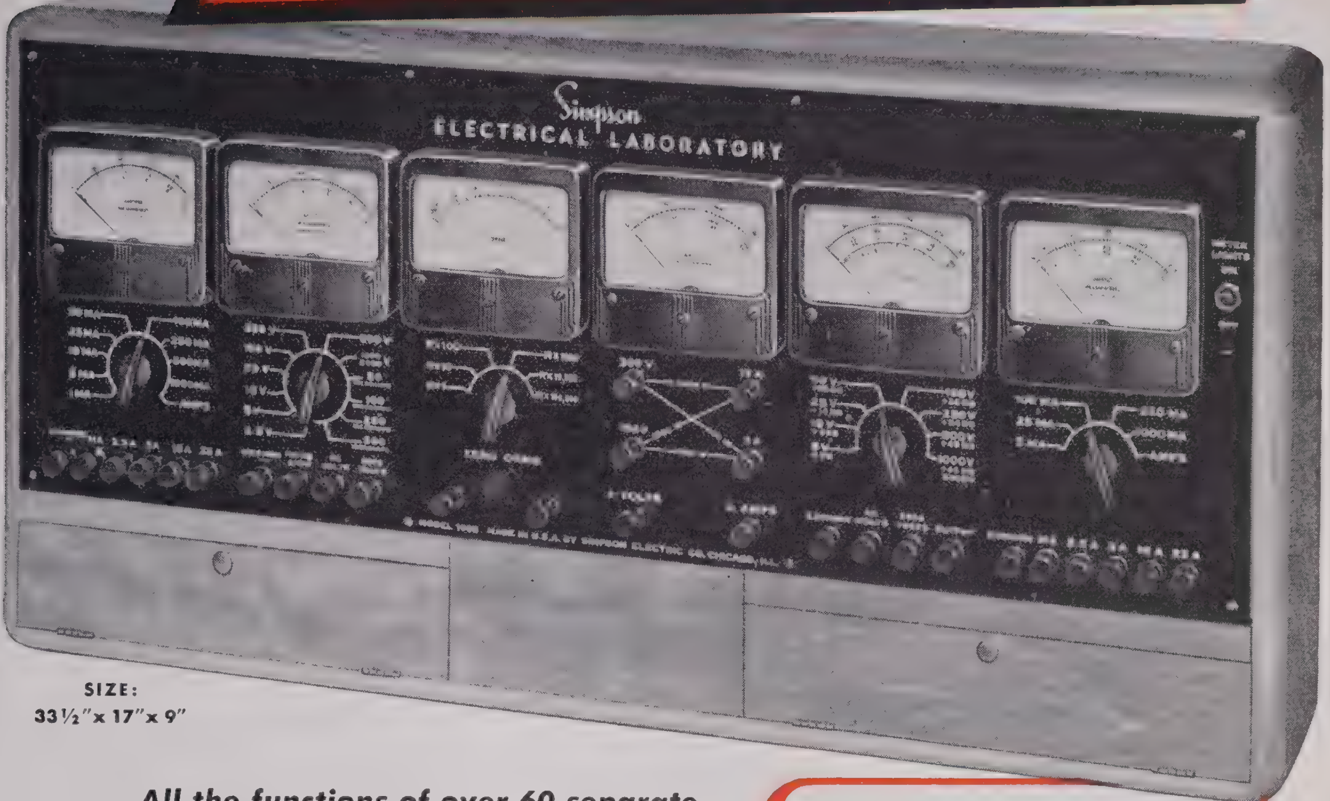
B.E.E. 1943 C.C.N.Y., M.S. 1948 Columbia University. Age 27. Married. Six years' experience on electronic research, product engineering and instructing including one year AAF service. Available June 1948. Prefer Omaha, Neb. or New York. Box 146W.

JUNIOR ENGINEER

School: RCA Institutes Inc., N.Y.C. 1948 Ex-Petty Officer Telegraphis (Royal Canadian Navy). Married. No children. Experience: Radio assembly. Operation, maintenance and installation of receivers, transmitters (LF, UHF), radar, RDF (LF, VHF), loran. Interested in engineering and sales. Box 147W.

(Continued on page 62A)

SIMPSON ELECTRICAL LABORATORY
MODEL 1005



SIZE:
33½″ x 17″ x 9″

All the functions of over 60 separate instruments combined in one unit!

Here is a complete test unit for use by radio, electronic, and electrical technicians in laboratories, shops, or service departments. It is adaptable to the testing of all electrical appliances, small motors, circuits, radio sets, etc. It consists of six individual 4½″ rectangular instruments, indirectly illuminated, each with a complete set of ranges.

In addition to the wide variety of A.C. and D.C. voltage and current ranges, a multi-range ohmmeter and a single phase wattmeter have been incorporated. Also, to meet the need for extreme sensitivity required in testing circuits where only a small amount of current is available, an instrument is provided with a sensitivity of 50 microamperes, providing 20,000 ohms per volt on all D.C. voltage ranges. The Electrical Laboratory incorporates a rectifier type instrument for measuring A.C. voltage with a resistance of 1,000 ohms per volt on all ranges. This latter instrument also has in combination a complete coverage of DB ranges, from minus 10 to plus 54 for volume indications.

This beautiful instrument is Simpson-engineered and Simpson-built throughout for lifetime service.

Dealer's Net Price, complete with Leads and Break-in Plug, $218.00

SIMPSON ELECTRIC COMPANY

5200-5218 West Kinzie Street, Chicago 44, Illinois
In Canada, Bach-Simpson Ltd., London, Ont.

Ask your jobber

Simpson

INSTRUMENTS THAT STAY ACCURATE

RANGES OF MODEL 1005

Meter No. 1
(D.C. Milliammeter and Ammeter)
0-1 MA. D.C.
0-5 MA. D.C.
0-10 MA. D.C.
0-25 MA. D.C.
0-50 MA. D.C.
0-100 MA. D.C.
0-250 MA. D.C.
0-500 MA. D.C.
0-1000 MA. D.C.
0-2.5 Amps. D.C.
0-5 Amps. D.C.
0-10 Amps. D.C.
0-25 Amps. D.C.

Meter No. 2
(D.C. Microammeter and Voltmeter)
0-2.5 Volts D.C.
0-5 Volts D.C.
0-10 Volts D.C.
0-50 Volts D.C.
0-100 Volts D.C.
0-250 Volts D.C.
0-500 Volts D.C.
0-1000 Volts D.C.
0-5000 Volts D.C.
20,000 ohms per volt
0-50 Microamps
0-100 Microamps
0-250 Microamps
0-500 Microamps

Meter No. 3
(Ohmmeter)

0-500 Ohms	(5 ohms center)
0-5000 Ohms	(50 ohms center)
0-50,000 Ohms	(500 ohms center)
0-500,000 Ohms	(5,000 ohms center)
0-5 Megohms	(50,000 ohms center)
0-50 Megohms	(500,000 ohms center)

Meter No. 4
(Wattmeter)
0-300 Watts A.C.
0-600 Watts A.C.
0-1500 Watts A.C.
0-3000 Watts A.C.

Meter No. 5
(A.C. Voltmeter, Output and DB meter)
0-5 Volts A.C.
0-10 Volts A.C.
0-25 Volts A.C.
0-50 Volts A.C.
0-100 Volts A.C.
0-250 Volts A.C.
0-500 Volts A.C.
0-1000 Volts A.C.
0-5000 Volts A.C.
Rectifier type 1000 Ohms per volt
DB Ranges
—10 to +54
Output Ranges same as volts except 5000 Volt Range

Meter No. 6
(A.C. Milliammeter and Ammeter)
0-5 MA. A.C.
0-25 MA. A.C.
0-100 MA. A.C.
0-250 MA. A.C.
0-1000 MA. A.C.
0-2.5 Amps. A.C.
0-5 Amps. A.C.
0-10 Amps. A.C.
0-25 Amps. A.C.

AMPHENOL

For installing metal industrial electron tubes on non-insulated surfaces
MEETS NEMA SPECIFICATIONS AND UNDERWRITERS' REQUIREMENTS
AMPHENOL

AMPHENOL TUBE MOUNTS, STAND-OFF INSULATORS AND FEED-THRU BUSHINGS

Amphenol tube mounts and stand-off insulators efficiently mount Thyratron 173, and similar metal industrial electron tubes, on non-insulated surfaces. Secure mounting and highest quality insulation are assured.

The use of steatite dielectric guarantees excellent heat resisting qualities, low-loss and high mechanical strength. Surface creepage distances of 2″ safely accommodate high voltages. Exposed portions of stand-offs are glazed to facilitate cleaning in dusty industrial plants.

Types with steatite feed-thru bushings allow wiring back of the supporting panel. Additionally, these insulators serve as tie points, or feed-thru insulators, for tube element connections, or for passage of high voltage circuits through panels or compartment walls. Complete electrical, mechanical and pricing data immediately available on request. Write for it today.

AMPHENOL

THESE FEATURES ASSURE TOP PERFORMANCE
- Mounts in small panel area
- Adequate clearance between tube and panel permits cooling by convection
- Wing nut connections simplify assembly and wiring maintenance
- Steatite dielectric

Amphenol tube mounts and stand-off insulators are designed for use with the following metal tubes: GL-414, FG-172, FG-280, FG-190, FG-166, ELC16J, EL60B, ELI6F.

AMERICAN PHENOLIC CORPORATION
1830 S. 54th AVE., CHICAGO 50, ILLINOIS
COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

Positions Wanted

(Continued from page 60A)

ELECTRICAL ENGINEER

B.E.E., R.P.I. (Communications). Age 26. Married. 1 child. Two years' Navy maintenance of radio and radar equipment. One year Civil Service testing VHF-UHF transreceivers. Current development of signal generators. Desires position as sales engineer. Box 148W.

ADMINISTRATIVE ENGINEER

Registered electrical engineer (N.Y.) FCC licensed. Eight years' experience in engineering, production, construction and administration; with power, communications and aircraft organizations. Harvard Business School graduate. Navy radar trained veteran. West coast preferred. Box 149W.

ELECTRICAL ENGINEER

B.S.E.E. Columbia, June 1948. Age 29. Married. 2½ years Naval radar; 1 year Naval Research Lab.; 1½ years' instructor in theory and shop practice; 5 years' experience in production planning and coordinator-metal and woodworking manufacturing. Tau Beta Pi. Desires position in design, development or production anywhere in the U. S. Box 150W.

ENGINEER

B.S.E.E. M.I.T., February 1943. Completing graduate work for E.E. degree (minor in Business Administration) Stanford, June 1948. Age 27. Married. One child. 3½ years' experience Naval shipboard and airborne electronics including assignments with N.R.L. and Airborne Coordinating Group (BuAero). Amateur Radio 10 years. Research or development. Box 151W.

ENGINEERING PHYSICIST

Army telephone central two years' test experience; graduate studies in higher math, physics, electronics; two credits remain to B.S. in engineering physics, Lehigh University, June, 1948; presently employed, seeking test research opportunity. Box 152W.

1948
March 22 - 25
Grand Central Palace &
Hotel Commodore
New York City
I.R.E. National Convention
Radio Engineering Show - Exhibits
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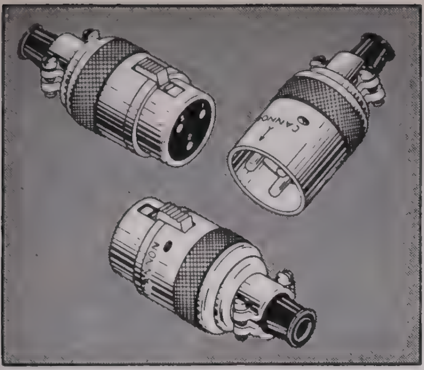
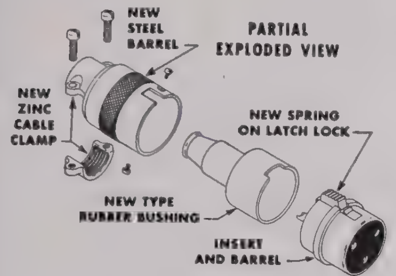
M



NEW AND IMPROVED TYPE "P" PLUG

On December 1st, 1947, Cannon Electric announced the completion of a new Type "P" to replace the P-CG-11 and P-CG-12 straight cord plugs. At the same time, list prices on all "P" fittings were revised, mostly up, a few down.



The new -11S and -12S plugs replace both the old -11, -12 and former -11S, and -12S. Features of the new fittings are shown by arrows on the view above. The shell is lightweight steel with an integral clamp of zinc. The zinc clamp is superior to the removable clamp and prevents twisting of leads. The rubber bushing adds insulating factors within the solderpot cavity and acts as a cable relief on the P2, and P3. The latch is stronger and better than on the old design.

For complete information, write for Special Bulletin No. PCG-1, and any other catalog material which you may require. Please use your company stationery when writing. Address Dept. C-377.

SINCE 1915

CANNON ELECTRIC
Development Company

3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.
IN CANADA & BRITISH EMPIRE:
CANNON ELECTRIC CO., LTD., TORONTO 13, ONT.
WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

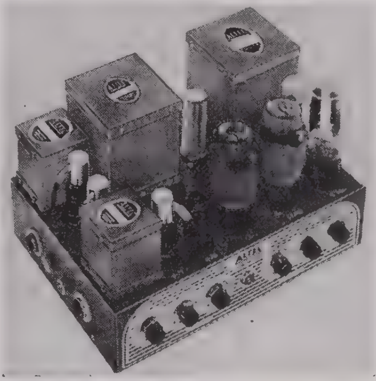
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Portable Amplifier

A new portable public-address amplifier engineered to provide quality consonant with the highest-priced microphones and loudspeaker systems has been brought out by **Altec Lansing Corporation,** 250 W. 57 St., New York 19, N. Y. The new amplifier is catalogued as Model A-324.



The A-324 is rated at 15 watts with a guaranteed full-power output within 1 db from 35 to 12,000 cycles. Its over-all frequency response is flat within 1 db from 20 to 20,000 cycles.

Several unique features are claimed for the new amplifier. Four inputs are provided: two of the inputs provide 95 db gain for low-impedance microphones with individual volume controls on each input for mixing purposes.

The transformer in the high-gain low-impedance microphone input circuits has 90 db shielding to guard against hum and noise pickup.

Two other high-impedance inputs provide 72 db gain for radio or phonograph pickup or high-impedance microphones; they are coupled to a dual-type volume control which allows fading smoothly from one input to the other.

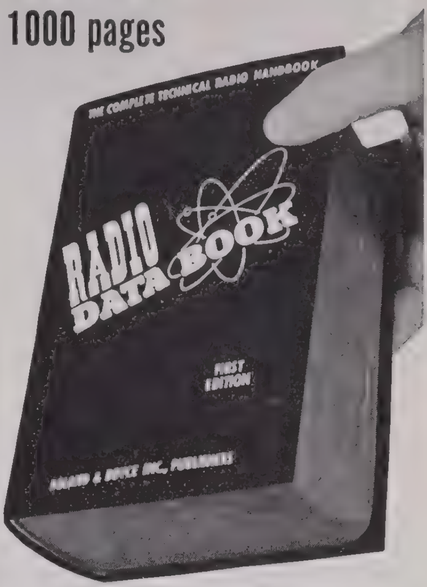
Another feature is a continuously variable bass control which, at the low end, is coupled to a switch to cut in special equalization to correct the boomy reproduction. A continuously variable treble attenuator is also provided.

New Enterprise

A new company, **International Rectifier, Corp.,** announces the opening of a plant at 6809 Victoria Ave., Los Angeles, Calif. The new firm is equipped for research and manufacture in the field of colorimetric equipment, photoelectric cells, and selenium rectifiers.

(Continued on page 66A)

NOW! at your Jobber's
1000 pages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RADIO DATA BOOK
FIRST EDITION
BOLAND & BOYCE INC., PUBLISHERS

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All data and basic knowledge in radio and electronics digested into 12 sections . . . in a complete, quick to find, easy to read, handbook form.

Plan every operation in radio and electronics with the Radio Data Book. This new radio bible will be your lifelong tool . . . you will use it every day, on the board, at the bench, in the field! Use it for engineering, construction, trouble-shooting and testing. The RADIO DATA BOOK will be your invaluable aid in design, experiment and in layout. It will help make your production better, faster and easier. In any and every operation in radio and electronics, you will use the RADIO DATA BOOK!

The RADIO DATA BOOK is a work of complete authority, prepared by engineers with many years of practical experience. They have been assisted by the Boland & Boyce staff of editors skilled in preparing electronics manuals for the U. S. Signal Corps for many years. These men have worked for several years gathering material for this book . . . all the knowledge of radio principles and operation . . . all the statistics . . . all the newest developments in electronics . . . every possible angle and detail. Eighteen months were spent digesting this material into the most concise, the clearest, and the most readable form. The result is this invaluable manual . . . The RADIO DATA BOOK. Whether you use this book for general reference, for scientific instruction, or for education, one thing is certain—the practical help, the daily usefulness you will derive from it will prove to be worth many, many times its astonishingly low price!

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Section 9. CODES, SYMBOLS AND STANDARDS.
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Unparalleled and highest practical order of obsolescence insurance—thru use of the precision 12 element, free-point Master Lever Selector System.

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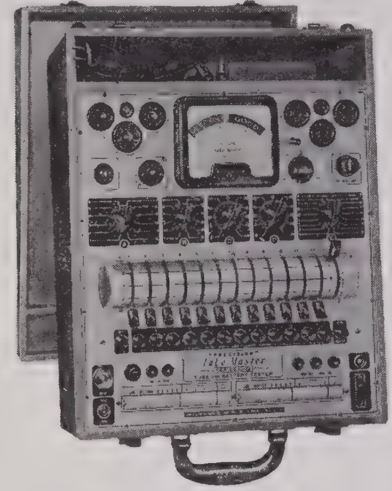
* Testing a tube for just one selected characteristic does not necessarily reveal its *overall performance capabilities.* Electronic tube circuits look *for more than just Mutual Conductance* or other single factor. In the Precision Master Electronic Tube Test Circuit, the tube under test is subjected to appropriately phased and selected individual element potentials and is electro-dynamically swept over a complete Path of Operation on a sinusoidal time base. Encompassing a wide range of plate family characteristic curves, this complete Path of Operation is automatically integrated by the indicator meter in the positive, direct and non-confusing terms of Replace-Weak-Good.



Model 10-12P; in sloping, portable hardwood case with tool compartment and hinged removable cover **$86.15**

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- Facilities to 12 element prongs.
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- ISOLATES EACH TUBE ELEMENT REGARDLESS OF MULTIPLE PIN POSITION.
- DUAL "special-purpose" short check sensitivity.
- Battery Tests under dynamic load conditions.
- Built-in brass-geared roller chart.
- 4½" Full Vision Meter.
- Panel Extractor Fuse Post.

ASK TO SEE the new "Precision" Master Electronamic Test Instruments on display at all leading radio parts and equipment distributors. Write for Precision 1948 catalog describing the Electronamic tube performance testing circuit.

PRECISION
APPARATUS CO., Inc.
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Elmhurst 12, N. Y.

Export Division: 458 Broadway, N. Y. C., U.S.A.
Cables: MORHANEX

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 65A)

Model S-5 Frequency Meter

Browning Laboratories, Inc., Winchester, Mass., announces the Model S-5 Frequency Meter for the accurate checking of transmitters operating between 30 and 500 Mc. A crystal standard in a temperature-controlled oven is employed with a long-time accuracy of 0.001%. The electron-coupled interpolation oscillator is assembled on an aluminum plate for mechanical stability and is temperature-compensated for minimum frequency drift. The meter is hand-calibrated for one, two, or three frequency bands in the range from 30 to 500 Mc. with an over-all accuracy of 0.0025%. High mixer sensitivity permits use of the instrument without the need of direct connection to the transmitter. A panel-mounted telescoping antenna is employed as a pickup means. The heavy steel cabinet which is provided may be removed and the instrument used in a relay rack with associated equipment. It measures 8¾ inches high, by 19 inches wide, by 9 inches deep, and weighs 35 pounds.

◆

Recent Catalog

• • • On crystals, Bulletin 36 containing a complete listing of all types of crystals currently manufactured by **Bliley Electric Co.,** Erie, Pa., for all types of commercial applications. This catalog does not contain crystals designed specifically for amateur application, as these units are described in Bulletin 35.

• • • On *Audigage,* a portable instrument designed to measure the thickness of a wide variety of materials, by **Branson Instruments Inc.,** Joe's Hill Rd., Danbury, Conn.

• • • On capacitors for electronic and service-replacement applications, a 24-page illustrated catalog, by **Cornell-Dubilier Electric Corp.,** So. Plainfield, N. J. Ask for Catalog No. 200.

(Continued on page 68A)

Longer life in service . . . higher dielectric strength

Smith Hi-Density Kraft Condenser Papers

These condenser papers have an average density at least 10% higher than normal condenser papers—a guaranteed minimum density of 1.05.

This gives 10% more insulation per sheet with no increase in thickness. The corresponding increase in dielectric strength permits engineers to design a capacitor to operate at higher voltages with the same thickness of insulation.

Smith Hi-Density Kraft Condenser Papers show a sizable increase in life characteristics over normal condenser papers.

Laboratory tests prove Smith Hi-Density Kraft Condenser Papers to be distinctly superior under accelerated life conditions, particularly under D.C. voltage.

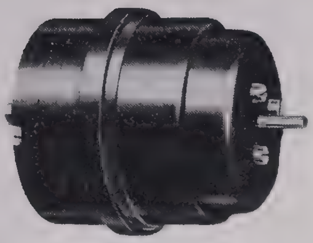
Tests also prove A.C. capacitors can be designed with increased breakdown voltage—therefore higher dielectric strength—without affecting the power factor.

Smith Hi-Density Kraft Condenser Papers cost no more than other condenser papers. For complete data, write Smith Paper, Inc., Lee, Massachusetts.

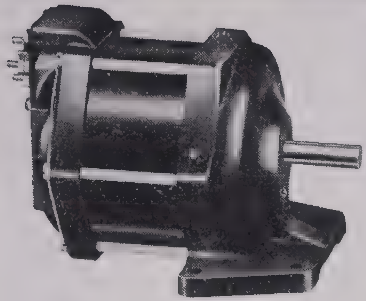
Be sure to pick up samples of Smith Hi-Density Condenser Papers at the Smith I. R. E. Convention Booth, No. 264—2nd floor.

Smith
ESTABLISHED 1835
Paper
Laboratory Certified

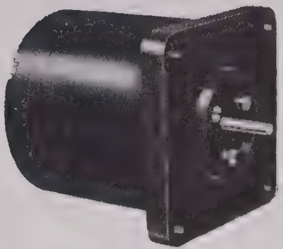
For precise, positive linkage between instrumentation and control



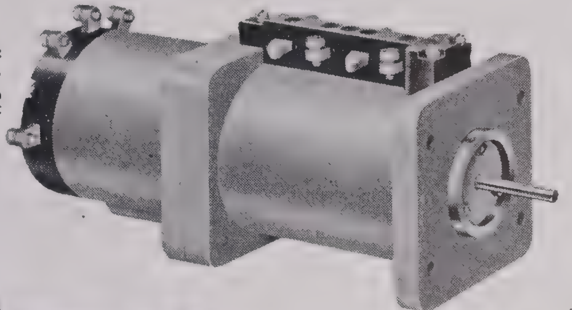
INDUCTION GENERATOR: when fed from AC source produces voltage proportional to speed of rotation. Used in circuits as velocity control component.



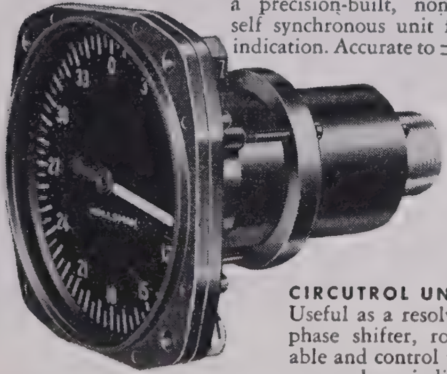
PERMANENT MAGNET GENERATOR: designed as AC potential source. Produces sinusoidal wave form with harmonic content under 2%.



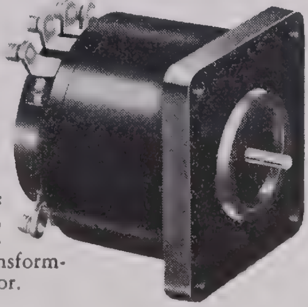
INDUCTION GENERATOR: type designed particularly for use where low residual voltage is required.



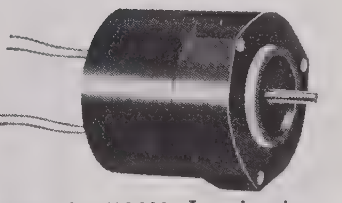
MOTOR DRIVEN INDUCTION GENERATOR: powered by 2-phase, low-inertia induction motor. Used as fast reversing servo motor where maximum stall torques of less than 7 oz. in. are required.



TELETORQUE UNIT — below left: a precision-built, non-motoring, self synchronous unit for remote indication. Accurate to ± 1 degree.



CIRCUTROL UNIT: Useful as a resolver, phase shifter, rotatable and control transformer or phase indicator.



INDUCTION MOTOR: Low inertia, two-phase squirrel cage unit for use as precision servo motor.

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To meet the varying needs of the electronics engineer in linking instrumentation up to control, Kollsman offers a group of units with sufficiently varied functions to solve a wide range of control problems. In nearly every case, units are available for operation at various voltages and frequencies to fit widely diversified electronic control and remote indication applications. These Kollsman units are the outgrowth of long development in aircraft instrumentation and control and — more recently — Kollsman's considerable work in this field for naval and military applications. They are light in weight, compact, and highly precise, so that engineers working with exact quantities will find them reliable to a high degree. Complete data on any or all of these units may be had upon request. Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

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PRODUCT OF

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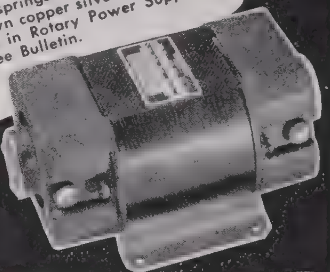

A WELL KNOWN NAME IN RADIO FOR OVER A QUARTER OF A CENTURY

RCA HAR-CAM Motorola COMCO FTR Federal Telephone & Radio GE Motor Research Laboratory, Inc. Palo Alto California KAAR ENGINEERING CO. RAY JEFFERSON, INC. Doolittle Marconi Harvey-Wells

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RELIABILITY . . . Designed especially for mobile transmitter use. Specified and preferred by Police Networks for over 14 years!
INSTANT POWER . . . Only CARTER GENEMOTOR delivers full output in less than 3/10 second! The fastest starting Dynamotor made.
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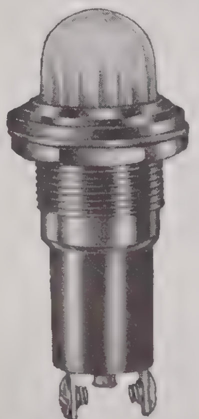

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 66A)

Recent Catalogs

• • •On the reduction of precipitation static in aircraft radio, an 8-page booklet published by **Dayton Aircraft Products, Inc.,** 342 Xenia Ave., Dayton, Ohio, manufacturers of shielded antenna fittings for commercial aircraft and for the U. S. Air Force.

• • •On synchronous timing motors and timing devices, a 16-page illustrated catalog by the **Haydon Manufacturing Co., Inc.** The catalog is divided into sections for each of nine different motor series and for the various types of timing devices, such as repeat-cycle and reset timers, time-delay relays, interval timers, etc. Copies may be obtained by writing E. B. Hamlin, Haydon Mfg. Co., Inc., East Elm St., Torrington, Conn.

• • •On a new signal generator, a 4-page illustrated technical bulletin issued by **Premier Crystal Laboratories, Inc.,** 53–63 Park Row, New York 7, N. Y., giving details and specifications of the new Model 117 Crystal-Controlled High-Frequency Mini-Signal Generator.

(Continued on page 70A)

ANOTHER *New* BROWNING DEVICE

SWEEP CALIBRATOR
MODEL GL-22

Prelaid timing marker oscillator for standard oscilloscopes and synchroscopes. Variable amplitude markers. Markers available at 0.1 to 100 microseconds.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

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READ MORE RANGES • MORE ACCURATELY • MORE EASILY

OHMS
10MEG 2MEG 1MEG
400K 2K 20
100K 500 5
40K 200 2
CAUTION ON HIGH VOLTS
5000V
MODEL 625 NA
V-Ω-MA-A
10AMP
5000V
1000V
250V
1000MA
100MA
10MA
1MA
50μA
40MEG
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OHMS ADJ
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"O" DB AT 1.73V ON 500 OHM LINE
OHMS PER VOLT 10,000-20,000 DC 10,000 AC

12 D. C. Voltage Ranges on 4.4″ scale. Mirrored for Accuracy. Special multipliers for permanent accuracy.

6 A. C. Voltage Ranges on 4″ Scale. Mirrored for Accuracy. Special multipliers for permanent accuracy.

6 D. C. Current Ranges on 4.4″ Scale. Mirrored for Accuracy. Wire wound shunts for permanent accuracy.

3 Resistance Ranges on 5″ scale. Mirrored for Accuracy. Special multipliers for permanent accuracy.

6 Decibel Ranges on 3.33″ scale. Mirrored for Accuracy. Special multipliers for permanent accuracy.

MODEL
625-NA
Dealer Net Price $45^00

For the Man who takes Pride in his work

The new Model 625-NA, with 39 ranges and many added features, is the widest range tester of its type. Note the long mirror scale on the large 6″ meter for easier, more accurate reading. Resistance ranges to 40 megohms give you all the ranges needed for general servicing, plus Television and FM. And with 10,000 ohms per volt A. C. you can check many audio and high impedance circuits where a Vacuum Tube Volt meter is ordinarily required. A proven super-service instrument for laboratory, field maintenance and radio repair.

Write for complete technical information on Dept. H38

RANGES

D. C. VOLTS: 0-1.25-5-25-125-500-2500, at 20,000 Ohms/Volt
0-2.5-10-50-250-1000-5000, at 10,000 Ohms, Volt
A. C. VOLTS: 0-2.5-10-50-250-1000-5000, at 10,000 Ohms Volt
D. C. MICROAMPERES: 0-50, at 250 Millivolts
D. C. MILLIAMPERES: 0-1-10-100-1000, at 250 Millivolts
D. C. AMPERES: 0-10, at 250 Millivolts
OHMS: 0-2000-200,000 (12-1200 at center scale)
MEGOHMS: 0-40 (240,000 ohms at center scale)
DECIBELS: −30 +3 +15, +29, +43, +55, +69
(Reference level "O" DB at 1.73 V. on 500 ohm line)
OUTPUT VOLTS: 0-2.5-10-50-250-1000-5000, at 10,000 Ohms/Volt

Precision first ... to Last

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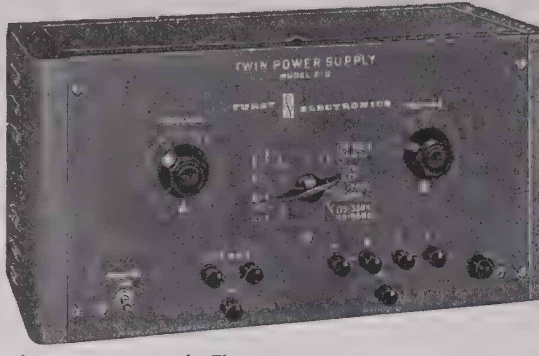
TRIPLETT ELECTRICAL INSTRUMENT CO. • BLUFFTON, OHIO
In Canada: Triplett Instruments of Canada, Georgetown, Ontario

TWIN Power Supply

Electronically Regulated for Precise Measurements



Two independent sources of continuously variable D.C. are combined in this one convenient unit. Its double utility makes it a most useful instrument for laboratory and test station work. Three power ranges are instantly selected with a rotary switch:

175-350 V. at 0-60 Ma., terminated and controlled independently, may be used to supply 2 separate requirements.
0-175 V. at 0-60 Ma. for single supply.
175-350 V. at 0-120 Ma. for single supply.

In addition, a convenient 6.3 V.A.C. filament source is provided. The normally floating system is properly terminated for external grounding when desired. Adequately protected against overloads.

- *Output voltage variation less than 1% with change from 0 to full load.*
- *Output voltage variation less than 1 V. with change from 105 to 125 A.C. Line Voltage.*
- *Output ripple and noise less than .025 V.*

Twin Power Supply Model 210
Complete $130.00
Dimensions: 16" X 8" X 8" Shipping Wt. 35 lbs.
(Other types for your special requirements)
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KENYON For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!

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NEW YORK 59, N.Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

Recent Catalogs

• • • A new edition of the RCA Receiving Tube Manual, designated as Technical Series RC-15, is now being distributed, according to an announcement by **Radio Corporation of America,** RCA Victor Division, Tube Department, Harrison, N. J. This is the first edition of the manual since 1939. In addition to greatly expanded coverage in its regular sections, the RC-15 presents many new features.

• • • On type "B" high-voltage resistors, a new catalog sheet, which presents engineering data, issued by **Resistance Products Co.,** Division of Electronic Manufacturing Co., 714 Race St., Harrisburg, Pa.

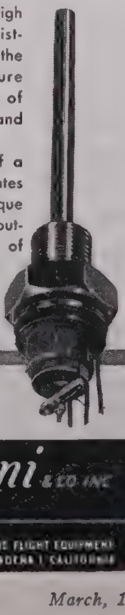
• • • On Flexible Waveguide Assemblies, an illustrated bulletin issued by **Technicraft Laboratories, Inc.,** 237 East Aurora St., Waterbury, Conn. Technicraft manufactures a complete line of rectangular flexible waveguide assemblies for use in the microwave spectrum. Three basic types are described in the bulletin: Type L, Interlocked Construction; Type S, Seamless Construction; and Type V, Vertebra Construction. Write to the manufacturer for Bulletin F-1.

(Continued on page 72A)

TEMPERATURE TRANSDUCER
from −65°c to +150°c

Latest type Giannini Temperature Transducer combines excellent range, large outputs and high accuracy. Available in resistances up to 20,000 ohms, the new type 4911 Temperature Transducer has a linearity of 1%, an accuracy of 1%, and a sensitivity of 1° C.

The instrument consists of a bi-metallic element that rotates a standard Giannini Microtorque Potentiometer for electrical outputs. This instrument is one of thirty basic Giannini developments in the telemetering field.



Write for complete engineering details.

GM Giannini & CO INC
REACTION POWER PLANTS • AUTOMATIC FLIGHT EQUIPMENT
[illegible] WEST COLORADO STREET • PASADENA 1, CALIFORNIA

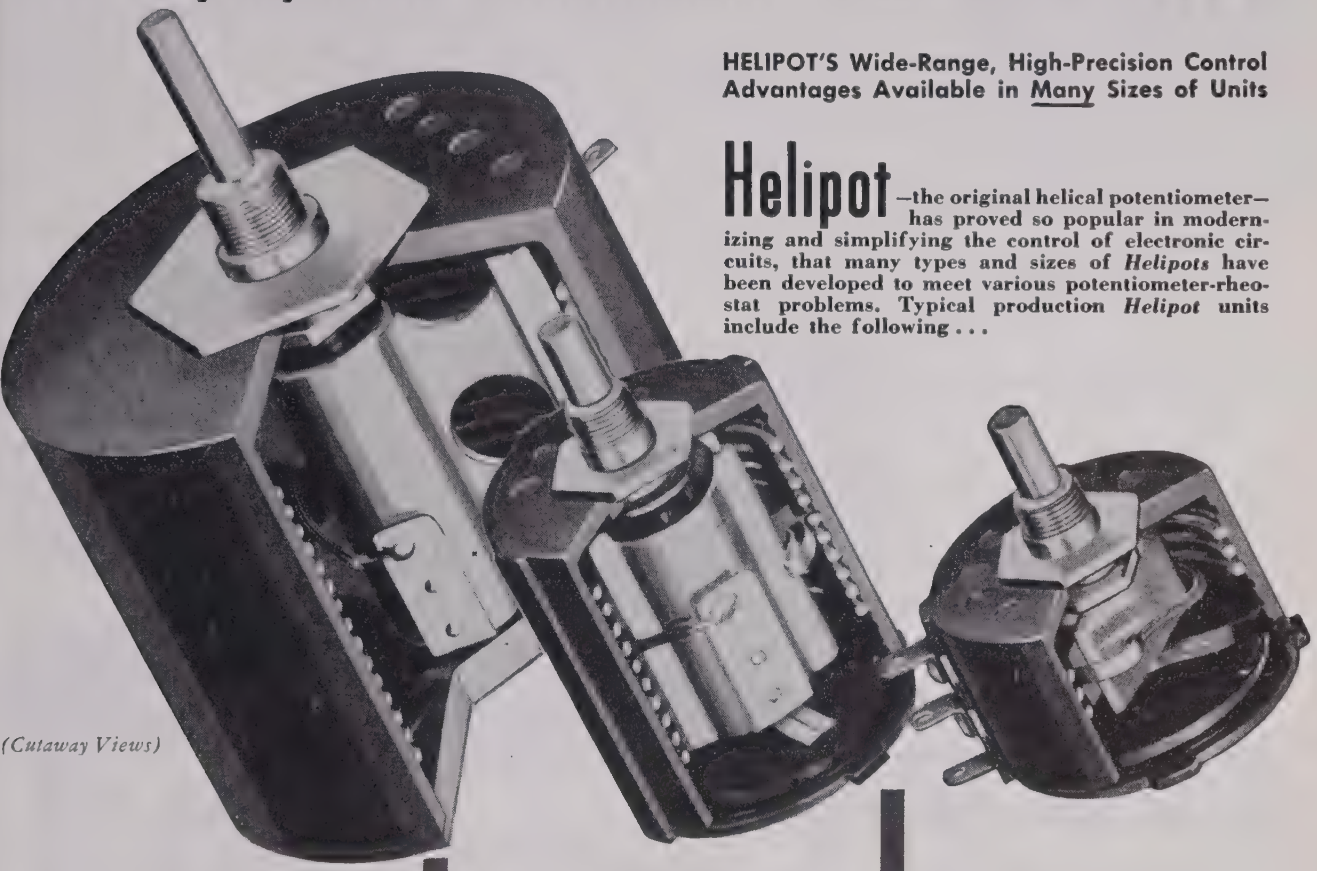
There's a Beckman Helipot

(Trade Mark of the **HELI**cal **POT**entiometer)

to simplify YOUR Potentiometer—Rheostat Problems!

HELIPOT'S Wide-Range, High-Precision Control Advantages Available in Many Sizes of Units

Helipot—the original helical potentiometer—has proved so popular in modernizing and simplifying the control of electronic circuits, that many types and sizes of *Helipots* have been developed to meet various potentiometer-rheostat problems. Typical production *Helipot* units include the following . . .



(Cutaway Views)

MODEL B—Case diameter—3.3"; Number of turns—15; Slide wire length—140½"; Rotation—5400°; Power rating—10 watts; Resistance ratings—50 to 200,000 ohms.

MODEL A—Case diameter—1.8"; Number of turns—10; Slide wire length—46½"; Rotation—3600°; Power rating—5 watts; Resistance ratings—10 to 50,000 ohms.

MODEL C—Case diameter—1.8"; Number of turns—3; Slide wire length—13.5"; Rotation—1080°; Power rating—3 watts; Resistance ratings—5 to 15,000 ohms.

WIDE CHOICE OF DESIGN FEATURES

Not only are *Helipots* available in a wide range of sizes and ratings, but also can be supplied with various design features to meet individual requirements . . .

- ▶ Available with special length shafts, flatted shafts, screwdriver slots, etc.
- ▶ Can be supplied with shaft extensions at each end to permit coupling to indicating instruments or other devices.
- ▶ May be provided in ganged assemblies of two or three units, all operating from a common shaft.
- ▶ Available with linearity tolerances of 0.1%—and even less.
- ▶ Models A & B can be modified to include additional taps at virtually any point on windings.

. . . and many other special features.

Investigate the many important advantages to be gained by using the *Helipot* in your electronic control applications. Write outlining your problem!

SPECIAL MODELS

In addition to the above standard *Helipot* units, special models in production include . . .

MODEL D—Similar to Model B, above, but longer and with greater length of slide wire. Case diameter—3.3"; Number of turns—25; Slide wire length—234"; Rotation—9000°; Power rating—15 watts; Resistance ratings—100 to 300,000 ohms.

MODEL E—Similar to Model B, but longer and with greater length of slide wire than Model D. Case diameter—3.3"; Number of turns—40; Slide wire length—373"; Rotation—14,400°; Power rating—20 watts; Resistance ratings—150 to 500,000 ohms.

Send for HELIPOT Literature!

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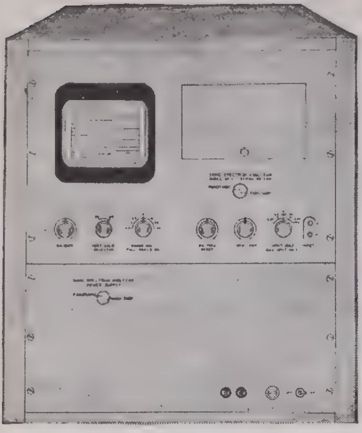
See the HELIPOT at the IRE Show, Booth 243. Also the new DUODIAL—the revolutionary multi-turn indicating knob dial!

Presenting AP-1 ! !



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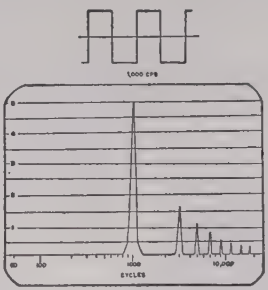
Waveforms



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RCA, Commercial Engineering,
Section CW52, Harrison N.J.

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☐ Quick-Reference Chart, Miniature Tubes (*Free*). [A]
☐ HB-3 Tube Handbook (*$10.00*)*. [B]
☐ RC-15 Receiving Tube Manual (*35 cents*). [C]
☐ Receiving Tubes for AM, FM, and Television Broadcast (*10 cents*). [D]
☐ Radiotron Designers Handbook (*$1.25*). [E]
☐ Quick Selection Guide, Non-Receiving Types (*Free*). [F]
☐ Power and Gas Tubes for Radio and Industry (*10 cents*). [G]
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☐ RCA Preferred Types List (*Free*). [I]
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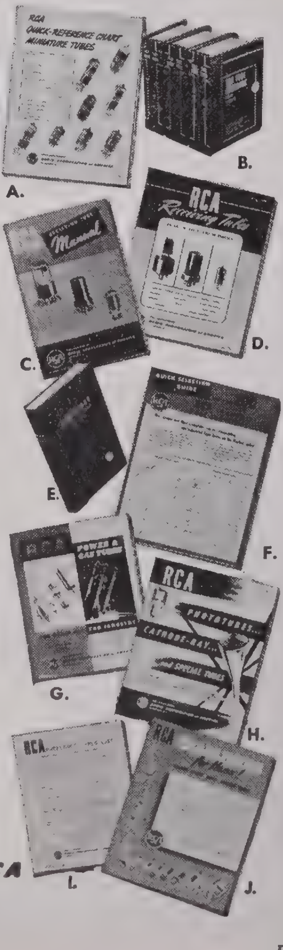
**Price applies to U. S. and possessions only.*



TUBE DEPARTMENT
RADIO CORPORATION of AMERICA
HARRISON, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 70A)

Recent Catalogs

• • •On resistors, rheostats, and relays for amateur use, a new catalog, No. D-30, published by **Ward Leonard Electric Co.,** Mount Vernon, N. Y. A copy of the new catalog may be obtained by writing to Radio and Electronic Distributor Division, Ward Leonard Electric Company, 53 W. Jackson Blvd., Chicago 4, Ill.

Interesting Abstract

• • •Several new illustrated bulletins describing various models of the *Original-Odhner* calculating machines have recently been issued by **Ivan Sorvall, Inc.,** 210 Fifth Ave., New York 10, N. Y., the sole U. S. distributor for these machines. These portable, hand-operated calculators will be of interest to the engineer as they feature a back-transfer device to speed up calculations, when series of multiplications and divisions are involved.

(Continued on page 80A)

ANOTHER *New* BROWNING DEVICE

CAPACITANCE RELAY
MODEL DD-20

Super-sensitive "brain" for alarm, safety, or signal systems. Operates alarm circuit on capacitance changes of 0.25 mmfd.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

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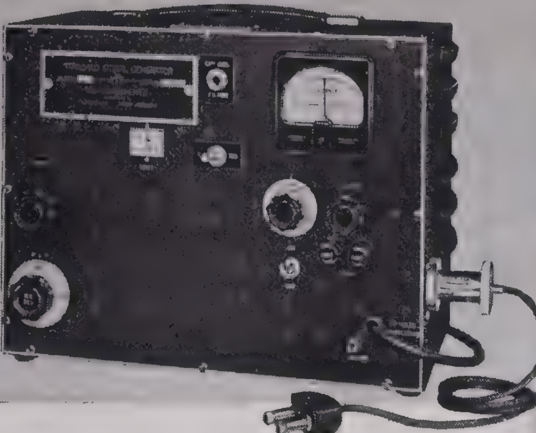
FREQUENCY MODULATED SIGNAL GENERATOR

MODEL 78FM

86-108 MC

Also Available For Other Frequency Ranges



1 to 100,000 MICROVOLTS

Variable Output With Negligible Carrier Leakage

MODULATION: 400 cycle internal audio oscillator. Deviation directly calibrated: 0 to 30 kc. and 0 to 300 kc. Can be modulated from external audio source.

Audio fidelity is flat within 2 db from dc to 15,000 cycles. Distortion less than 1% at 75 kc. deviation.

The Model 78FM when used with Measurements Model M-275 Converter provides output in the IF ranges of 4.5, 10.7 and 21.7 mc.

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- Standard Signal Generators
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BOONTON NEW JERSEY

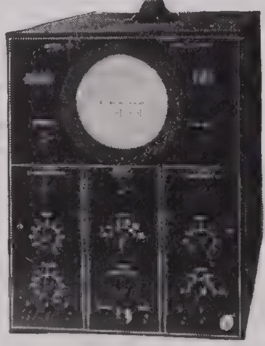
EDL LEADERS IN THE DEVELOPMENT OF ELECTRONIC INSTRUMENTS

Announcing THE EDL WIDE RANGE OSCILLOSCOPE

PERMITS DIRECT OBSERVATION OF COMPOSITE VIDEO SIGNAL

Embodying many recent developments is the new EDL, Model 75, wide range oscilloscope. Vertical amplifier response is ±2 DB from 10 cycles to 5 MC—permitting study of television signals and all waveforms with high harmonic contents.

An extremely desirable feature of this versatile instrument is a self contained voltage calibrator with an accuracy of ±5%. Test probe has shielded cable to eliminate stray pickup.



Model 75

FEATURES

Vertical Amplifier:
Response— ±2 DB 10 cycles to 5 MC
Sensitivity—Direct—.1 volts RMS per inch
Sensitivity With Probe—1.0 volts RMS per inch

Horizontal Amplifier:
Response— ±2 DB 10 cycles to 200 kc
Sensitivity—.5 volts RMS per inch

Sweep Frequency—10 cycles to 60 kc.

WRITE FOR FURTHER DETAILS

EDL Instruments
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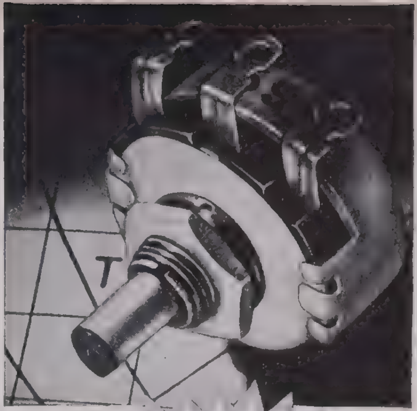

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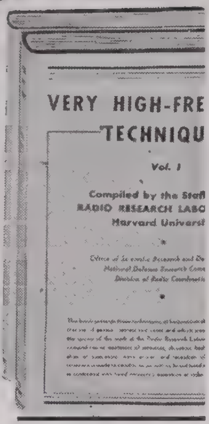
Research data on:

- **—Antennas**
- **—Direction Finding Systems**
- **—Generation of Continuous Wave Power**
- **—Reception of Signals**



• Now you can have access to a great accumulation of valuable research data on radio techniques at very high frequency. This two-volume set presents a comprehensive treatment of antennas, direction finding systems, generation of continuous wave power and reception of signals, at frequencies above about 100 megacycles. Particular reference is made to conditions permitting broad band or tunable operation. Much of the emphasis is on continuous wave lengths. The volumes deal chiefly with broad band modulation and amplification, wide frequency range, and simplicity of tuning.

VERY HIGH FREQUENCY TECHNIQUES

Compiled by the Staff of the RADIO RESEARCH LABORATORY, Harvard University. Developed under sponsorship of the Office of Scientific Research and Development

Under the Direction of

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Two volumes, not sold separately, 1100 pages, well illustrated, $14.00 the set

These two volumes provide engineers, physicists and researchers with access to the important techniques developed during the war at the Radio Research Laboratory at Harvard, at frequencies above 100 megacycles—enable them to save considerable time and effort in the solution of problems in this field. Hundreds of careful diagrams, charts, graphs, drawings and circuit diagrams are included.

Here are some of the subjects presented

- broad-band antennas
- impedance matching: transformers and baluns
- cone and cylinder antennas
- principles of direction finding
- triode and pentode ultrahigh-frequency oscillators
- coaxial-line power amplifiers and oscillators
- power output coupling methods
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- principles of magnetron operations
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NEWS—NEW PRODUCTS

The manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 72A)

Voltage Regulator Tube

The Tube Department, **Radio Corp. of America,** Harrison, N. J., has announced production of the OB2 voltage regulator tube, which, like the OA2, is a miniature cold-cathode glow-discharge tube.

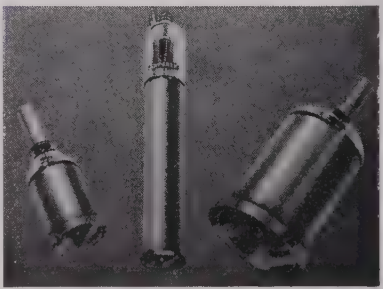
The OB2 regulates at approximately 108 volts over a current range of 5 to 30 ma., whereas the OA2 regulates at approximately 150 volts. These two types permit equipment designers to provide regulated B and C voltages in compact equipment where space heretofore precluded use of the larger voltage-regulator tubes.

New Folded Dipole

A folded dipole designed for use as a receiving or transmitting antenna in the 85- to 150-Mc. range is being introduced by the Communications Equipment Division of **Heintz and Kaufman, Ltd.,** 50 Drumm St., San Francisco, Calif.

This dipole can be accurately tuned to any frequency within this range; hence it is adaptable for f.m. reception, aviation service, the amateur two-meter band, and mobile services in the vicinity of 150 Mc. For 85 Mc. operation the dipole is extended to 65 inches; at 148 Mc., its over-all length is reduced to 37 inches.

Geiger-Mueller Counter Tubes



The illustration shows the redesigned beta, gamma and X-ray counter tubes now being produced by **Amperex Electronic Corp.,** 25 Washington St., Brooklyn 1, N. Y.

The manufacturer has long supplied these tubes as laboratory devices to supply the special needs of research physicists. Now, they are redesigned for standardized production.

Brochures describing the many counter tubes now in regular production are available upon request directed to the manufacturer.

(Continued on page 82A)

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coupled with the
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for
high quality
plus efficient performance

The new, RMC Hyper-Mag Speaker represents an outstanding advance in the art of Speaker design and development. The center dome with its parabolic projector, and the special magnet design provides a high quality, efficient unit for FM and wired music installations. The result of many years' research and skillful engineering, the RMC Hyper-Mag Speaker offers a linearity of response from 98 to beyond 8500 cycles and an extremely low distortion. Naturally, RMC quality and fine workmanship are plus advantages.

Sold through local jobber. Write for Speaker Bulletin HS51

Export: Rocke International Corporation, 13 East 40th Street, New York 16, New York

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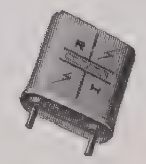
RH-9



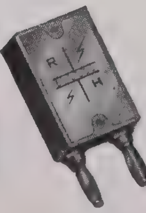
RH-7B

Reeves-Hoffman Crystal Units are produced under rigidly controlled manufacturing conditions. Low humidity, close temperature control, and dust free air assure precision and dependable performance of each unit.

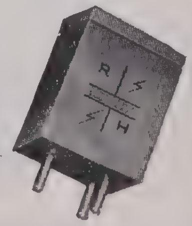
Individual Testing of each unit assures uniformity of production. All units of a type must produce the same test results.

Pre-Aging of All Crystal Units and etching to frequency assures not only extreme accuracy but prevents any future frequency drift due to aging.

For Complete Information write for catalog RHC-1.



RH-12



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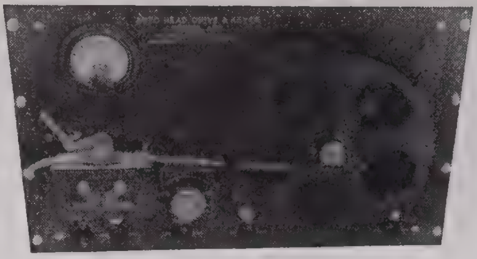
TERMINAL EQUIPMENT

by

McElroy



TYPE ADK

TYPE RAPC

FOR HIGH SPEED RECORDING *and* TRANSMITTING

McElroy Manufacturing Corporation announces an entirely new line of high speed recording and transmitting terminal equipment. For the first time, McElroy makes available a mechanical Wheatstone keying head capable of continuous operation at 500 words per minute, and a compact undulator tape recorder which is tested at speeds up to 1500 words per minute, and capable of recording high speed Morse, teletype or other intelligence where a fast accurate pulse mechanism is required.

•

Illustrated are the new ADK and RAPC units. The ADK keys Wheatstone tape at any variable speed up to 500 words per minute and provides polar, voltage, relay, or tone output. The RAPC pulse type recorder will accept contact, tone, voltage and frequency shift input and record such inputs at speeds up to 1500 words per minute.

•

The heart of this equipment is the new McElroy variable speed drive, used in the units described above and in the new high speed tape pullers. Set arbitrarily at 60 words per minute, a Strobotac will reveal no variation in speed with any reasonable load.

•

See this new equipment at our booth at the I. R. E. Show, and let our engineers convince you of the new ease in operating possible with the new McElroy equipment.

McELROY MANUFACTURING CORP.

Made at . . . Telegraphers Lodge, Littleton, Mass.

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 80A)

Interesting Abstracts

• • • Expansion of **Industrial Television, Inc.,** formerly of 36 Franklin Ave., Nutley, N. J., was indicated by recent announcements that the company has signed a long-term lease for a two-story building at 359 Lexington Ave., Clifton, N. J. and that a sales office is being opened at 354 Fourth Ave., New York, N. Y. Industrial Television specializes in the manufacture of large-screen, direct-view Teleceivers.

• • • **Leeds & Northrup Company,** Stenton Ave., Philadelphia, Pa., manufacturers of electrical measuring instruments, automatic controls, and other equipment, have announced the purchase of a two-story-and-basement building at 34 East Logan St., one block from its main plant.

• • • **The Minnesota Electronics Corp.,** Oppenheim Bldg., Sixth & Minnesota Sts., St. Paul 1, Minn., makers of the *Goodell* line of radio-phonographs, announce a new Dynamic Noise Suppressor Amplifier under a license agreement with Hermon Hosmer Scott, inventor of the dynamic noise suppressor.

• • • A comprehensive expansion program for stepping up the production of television picture tubes at the Lancaster, Pa., plant of the **Radio Corporation of America,** was announced by L. W. Teegarden, vice president in charge of the RCA Tube Department. At present the plant is turning out tubes for both the transmission and reception of television as well as power and other special types of tubes.

• • • The **Wire Recording Corporation of America,** 1331 Halsey St., Brooklyn, N. Y., recently incorporated, has taken over the assets and manufacturing facilities of the St. George Recording Equipment Co. of New York City. J. J. Sullivan, president of the newly formed corporation, announces completion of plans to manufacture the *Wireway* Wire Recorder.

(Continued on page 85A)

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Mrs. Harriet P. Watkins, I.R.E. Industry Research Division, Room 707, 303 West 42nd St., New York 18, N. Y.** Photographs, and electrotypes if not over 2″ wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 82A)

Midget Wire-Wound Resistors

Handy, inexpensive, ceramic-cased midget wire-wound resistors for tight spots and for facilitating point-to-point wiring, known as Greenohm Juniors, are announced by **Clarostat Mfg. Co., Inc.**, 130 Clinton St., Brooklyn, N. Y. These resistors take the place of more cumbersome and costly bracket-mounted units, especially where space is at a premium.

This "junior" version of the well-known Greenohm power resistors features a wire winding on a fiber-glass core, with axial bare pigtail leads clinched to the ends, placed in a steatite tube and thoroughly filled and sealed with cold-setting inorganic cement. Since there is no organic material in this resistor, it will not blister, crack, or change shape.

BUILD BETTER ELECTRONIC EQUIPMENT *with* STANDARDIZED

READY-TO-USE CABINETS • CHASSIS • PANELS • RACKS

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for ALL P. A. NEEDS

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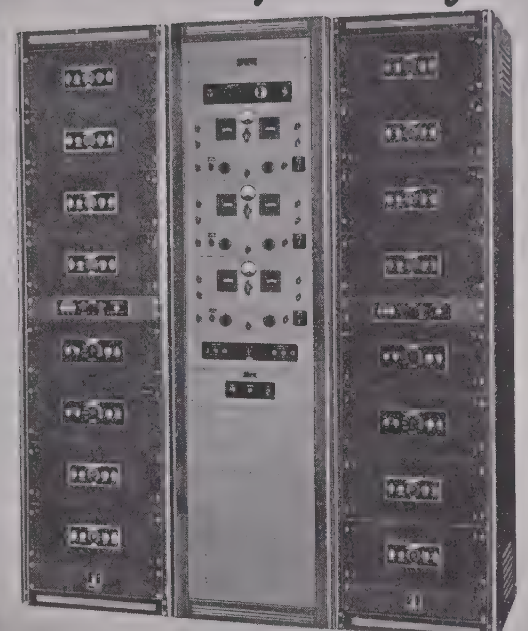

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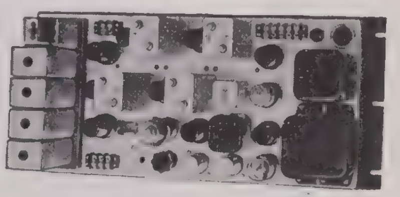
An outstanding development is the new, all crystal controlled 250-T exciter. New highs in stability have been achieved and all forms of spurious output frequencies eliminated. Instant selection of three operating channels, each preset to its individual carrier frequency and Mark-Space shift requirement, is available.

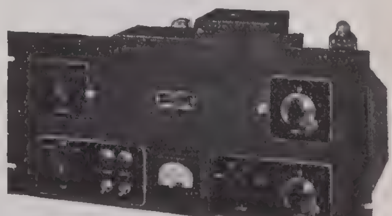
Receiver converter 216-S is used with the 87-R receiver and its output functions will drive a teletype printer, tape recorder or tone oscillator. This combination can be implemented on diversity or non-diversity telegraph circuits.

In addition to above, we manufacture a complete line of tone converters, transmitters, VHF channeling equipment and other apparatus for high speed telegraph communication. Write for literature.

Typical of their adaptability, standard Erco units were combined into this packaged receiving station which provides multichannel dual diversity reception of high speed radio type FST signals.



TYPE 87-R RECEIVER
The 87-R is specifically designed for the reception of high speed FST signals where a high degree of stability, sensitivity and selectivity is required under continuous operating conditions.



TYPE 250-T EXCITER
The 250-T all crystal controlled exciter is designed to key a radio telegraph transmitter by the frequency shift method and replaces the existing oscillator in the transmitter.

ERCO RADIO LABORATORIES INC
GARDEN CITY, NEW YORK

ERCO

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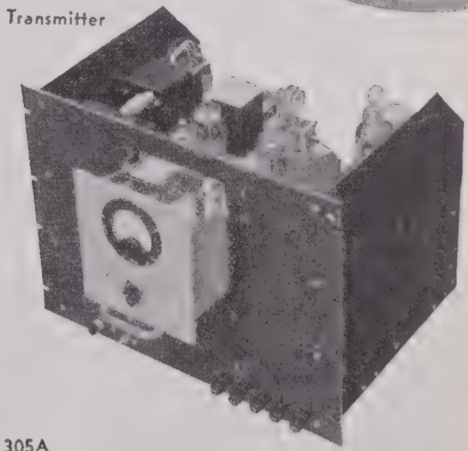
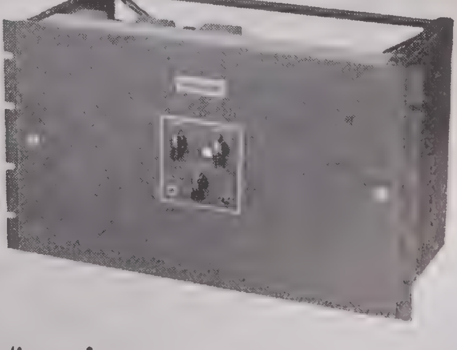
364A
Transmitter



305A
Receiver



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Television Transformers ... tailored to your needs

1. Line supply voltage and frequency
2. High voltage d-c required
3. D-c milliamperes required
4. Filament volts and amperes
5. Sub-panel or above-panel mounting
6. Description of rectifier circuit
7. Winding insulation voltage required
8. Maximum ambient temperature

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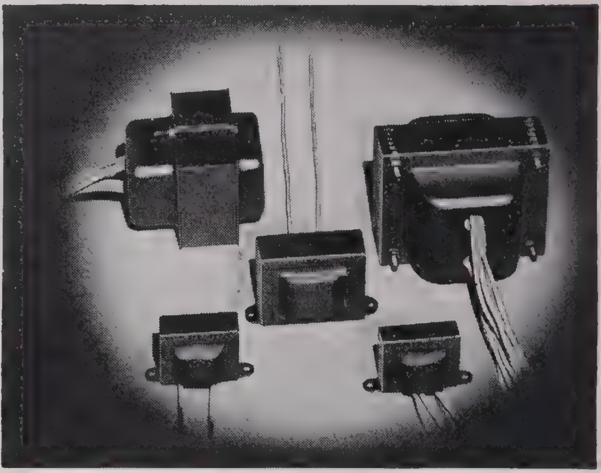


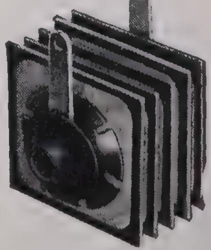
Whatever your transformer needs—power units like these, or special designs for deflection yokes, horizontal or vertical sweeps, or oscillators—General Electric can supply them . . . and quickly. G.E. offers its facilities and engineering "know-how" to television manufacturers in tailoring these transformers to their requirements. Just tell us your specifications and we will meet them to your complete satisfaction. Power-supply transformers are available now in core-and-coil and enclosed-case styles as standard units designed for television applications. Units for other uses are tailor-made from standard parts. Ask your G-E representative for more information; you'll be pleased with the prices and shipments he will offer you.

NEW PYRANOL CAPACITORS SAVE SPACE, WEIGHT, MONEY

If you have been using 600-volt d-c capacitors on circuits rated 400 volts or less, you're in for a substantial saving in weight, size and cost by specifying General Electric's new 400-volt Pyranol units. Compared with 600-volt ratings, these new, standard, 400-volt capacitors will save you from 24 to 51 per cent in volume, 23 to 33 per cent in weight, and approximately 10 per cent in cost. They are available in 2-, 4-, 6-, 8- and 10-muf ratings with solder-lug or screw-thread terminals optional on the four larger sizes; the 2-muf size comes with solder-lug terminals only.

New developments, such as silicones and new paper, are continually improving the quality of G-E capacitors. They also permit our engineers to handle your new requirements to your complete satisfaction. Write for quotation on any capacitor needs, or check Bulletin GEA-2621 for more information on the new d-c line described above.

NEW, SMALLER SELENIUM RECTIFIER



This new General Electric selenium rectifier, less than one inch long and one inch square, is available now for receiver and other elec-

GENERAL ELECTRIC

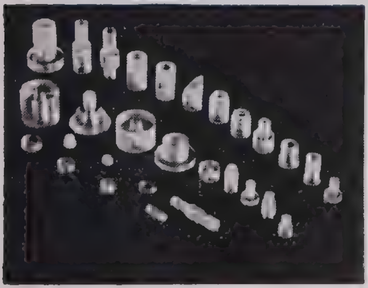
Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

tronic applications. It costs little and mounts in places where a rectifier tube and socket won't fit. Tests prove that this new selenium rectifier will outlast several 117-volt rectifier tubes. Installation is easier too—only two soldering operations and a minimum of mounting hardware are required.

These rectifiers have an exceptionally high inverse-peak rating, and the inverse current is extremely low even with peak voltages up to 350 volts. At rated current output, the forward drop is five volts or less. Ratings are based on ambients of 50 to 60 C. Check Bulletin 21-127 for more information on this and other General Electric radio rectifiers.

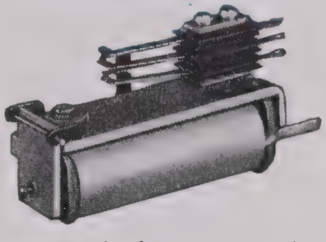
NEW MACHINABLE PLASTIC FOR UHF INSULATION



A new arrival in the plastics insulator field is G-E No. 1422, which offers characteristics of advantage in the manufacture of ultra-high-frequency equipment, television, FM, radar, and radio sets, and many other electronic applications. Possessing a dielectric constant of 2.5 to 2.6 with a power factor of .0006 to .0009 at 3000 mc, G-E No. 1422 exhibits unusual heat resistance and excellent machinability.

Indicative of its machinability is the industrial production of r-f connector beads from G-E No. 1422 on automatic and semi-automatic screw machines. As a low-loss dielectric in the hands of the electric-equipment designer, it affords an excellent low-cost means of producing experimental models and small production quantities through the use of standard machine shop tools. Check coupon for technical report.

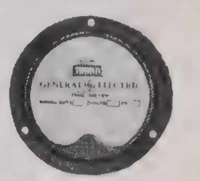
HANDLES 12 CIRCUITS SIMULTANEOUSLY



This new telephone-type relay is capable of handling as many as 12 circuits in a wide variety of contact combinations. Designed for multipurpose use in industrial electronic apparatus, communications and signaling equipment, these devices have service lives measured in millions of operations. Working from five basic contact arrangements, combinations can be stacked to satisfy intricate circuit switching requirements. Silver, palladium, or tungsten contacts can be supplied; the choice depends on rating and life specifications.

More than 500 different coils are available, with ratings ranging from 1 to 250 volts, and 0.1 to 26,000 ohms. This varied selection of coil ratings makes it possible to match closely the coil voltage and resistance with the rating of the energizing circuits. Check Bulletin GEA-4859 for full details.

TO MEASURE TUBE LIFE



Now available for immediate delivery, General Electric Type KT time meters are ideal for inclusion in transmitters and other electronic equipment where knowledge of tube "on time" is important. They can record operating time in hours, tenths of hours, or minutes, and are built in four forms: round or square for panel mounting, portable with attached base, or for conduit mounting. Those designed for panel mounting are housed in small Textolite cases that harmonize with other panel devices.

Telechron motor drive assures an accurate record of tube operation over a long period of time. They can also be used on electronic production tools, such as resistance welders, to keep an accurate record of machine operating time. Researchers use them for measuring time intervals, verifying circuit operation, and life testing. Bulletins GEA-3299 and GEA-1574 have full details.

GENERAL ELECTRIC COMPANY, Section H642-16
Apparatus Department, Schenectady 5, N. Y.

Please send me:

☐ **GEA-2621** **400-v D-c Capacitors**
☐ **GEA-3299** } **Type KT Time Meter**
☐ **GEA-1574** }
☐ **21-127 Selenium Rectifier**
☐ **GEA-4859 Telephone-type Relay**
☐ **Report on G-E No. 1422 Plastic**

NOTE: More data available in Sweets' File for Product Designers.

Name..........

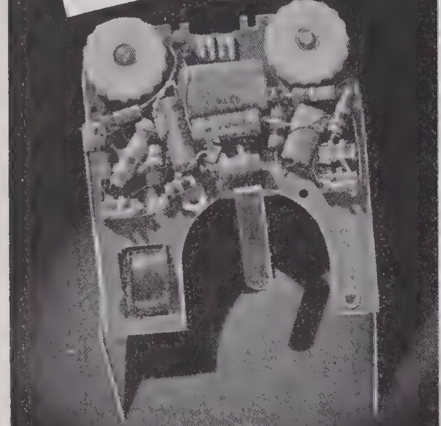
Company..........

Address..........

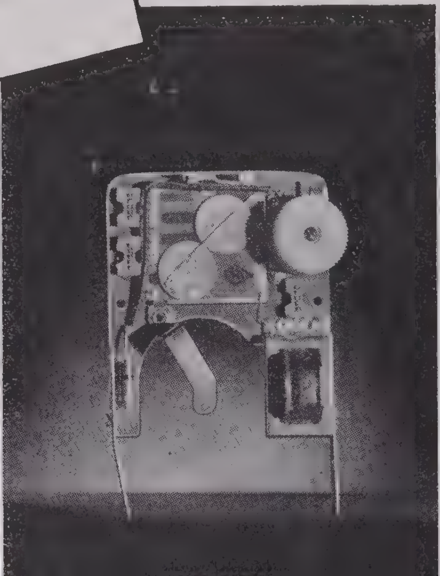
City.......... State..........

PROGRESS REPORT ON P.E.C.*

How Beltone uses Centralab's "Printed Electronic Circuit" to design and manufacture the "world's smallest hearing aid"



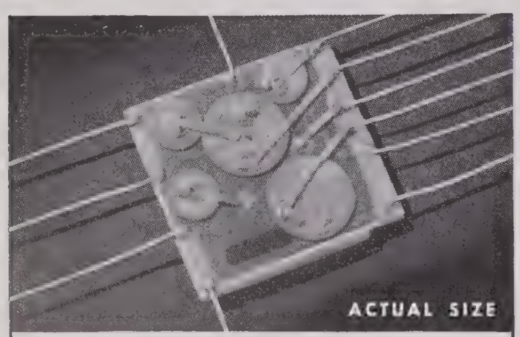
PROBLEM:
How to overcome size and weight limitations of ordinary electronic components and design a smaller, lighter Beltone hearing aid.



SOLUTION:
Using Centralab's "Printed Electronic Circuit", 45 parts, including capacitors and resistors, have been combined into one compact chassis.

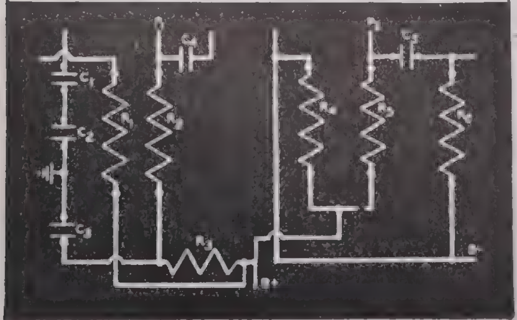
RESULT:
The new, vastly improved 1948 Beltone Hearing Aid—smaller and lighter with improved performance and important production savings.

Models courtesy of Beltone Hearing Aid Co., Chicago



ACTUAL SIZE

REAR VIEW of Beltone PEC unit is shown above. Note ceramic disc capacitors, "printed" silver leads and resistors (black paths). See below for schematic diagram of entire *Printed Electronic Circuit.*



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

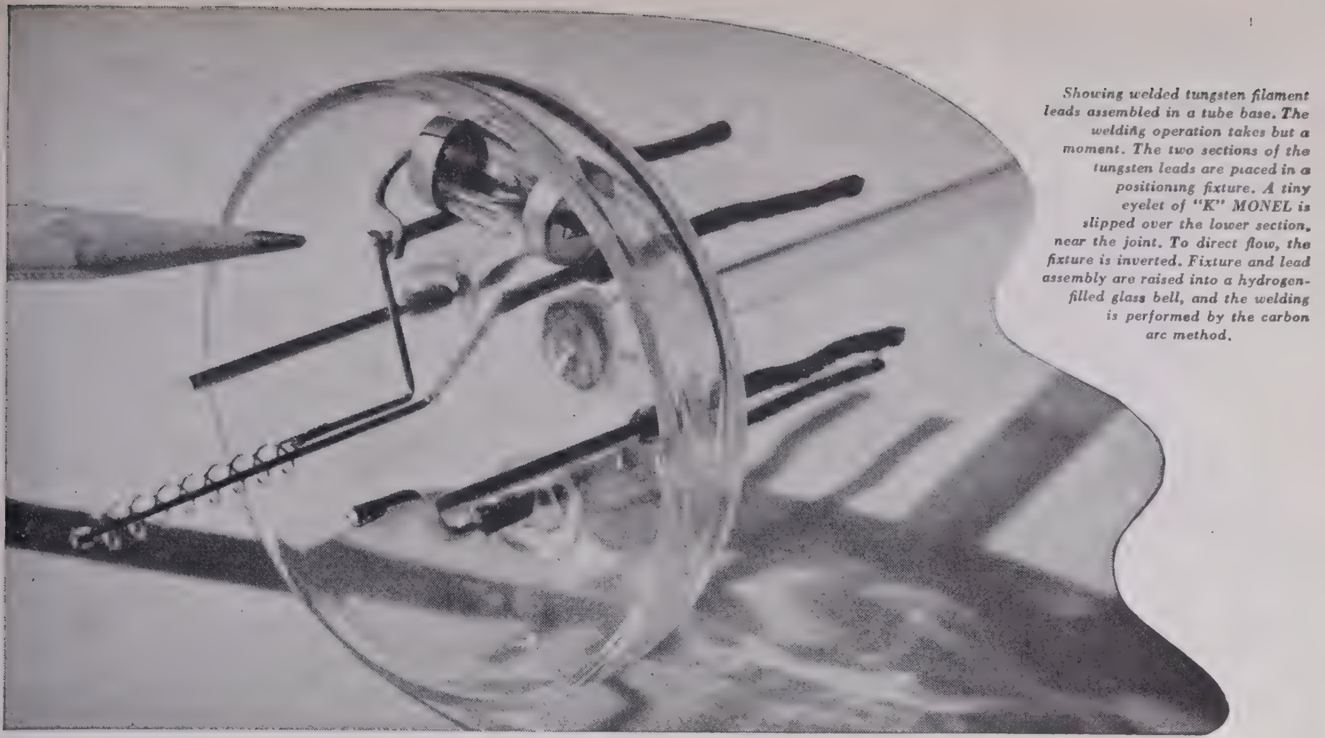
FOR USE where miniature size is of the utmost importance, nothing has ever been offered to manufacturers of electronic equipment which combines ruggedness, dependability and resistance to humidity and moisture in such a small unit package. That's what engineers of the Beltone Hearing Aid Co., Chicago, say about CRL's *Printed Electronic Circuit,* and that's what you will say when you have seen and tested this amazing new electronic development.

Integral ceramic construction: Each *Printed Electronic Circuit* is an integral assembly of "Hi-Kap" capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate. All leads are always the same length, each plate is an exact duplicate of the original or "master".

This outstanding new hearing aid development, illustrated above, was the product of close cooperation between Centralab and Beltone engineers. Working with your engineers, Centralab may be able to fit its *Printed Electronic Circuit* to your specific needs. Write for complete information, or get in touch with your nearest Centralab Representative.

LOOK TO **Centralab** CRL IN 1948!

Division of GLOBE-UNION INC., Milwaukee



Showing welded tungsten filament leads assembled in a tube base. The welding operation takes but a moment. The two sections of the tungsten leads are placed in a positioning fixture. A tiny eyelet of "K" MONEL is slipped over the lower section, near the joint. To direct flow, the fixture is inverted. Fixture and lead assembly are raised into a hydrogen-filled glass bell, and the welding is performed by the carbon arc method.

How a problem in welding tungsten was solved

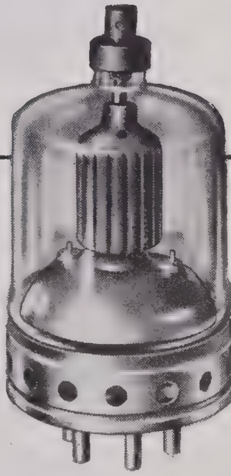
While improving the design of their VHF beam tetrodes, the United Electronics Company ran into a difficult technical problem.

In their tube types 5D22 and 4D21, tungsten filament leads are brought out to conventional base prongs. However, to locate the filament at the center of the structure, the two internal filament leads had to be sharply offset. It was necessary, also, that the leads be accurately aligned with the base outlet holes, to eliminate stresses which might crack the glass envelope when the tube was put in service.

Bending the tungsten leads to shape proved too inaccurate a method. So it was decided to make the leads in two sections — one straight, and one bent — welding them together in precision positioning fixtures.

This method of assembly proved satisfactory, but difficulty was immediately encountered in finding a suitable joining metal.

Several metals were tried without success. Either they failed to "wet" the tungsten, or caused it to embrittle.



VHF beam tetrode tube, manufactured by the United Electronics Co., Newark, N.J. ▶

Finally, United Electronics Company engineers tried "K"* MONEL—*and it proved to be the answer to their problem.*

"K" MONEL "wet" the tungsten satisfactorily; flowed well; made strong, smooth joints; was resistant to oxidation and corrosion. In addition, "K" MONEL's melting point was safely above both exhausting and tube operating temperatures.

This is but one of countless ways that Nickel and its alloys are helping industry to build better products. If you have a problem in metal selection, get to know the family of INCO Nickel Alloys with their unique combination of properties. Our technical department is always ready to assist you. Write for "Inco Nickel Alloys for Electronic Uses."

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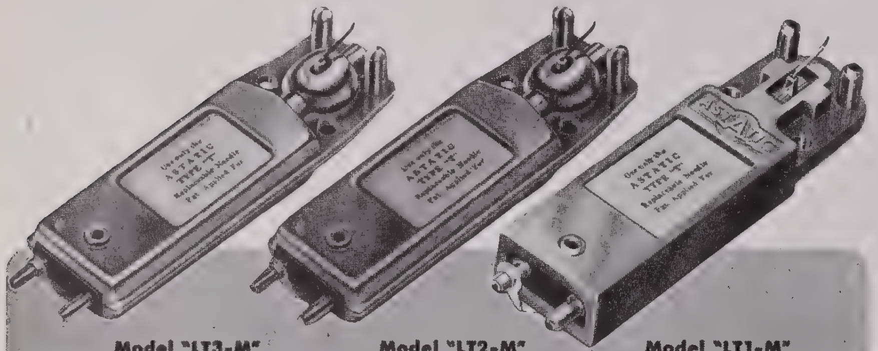
Incorporate the Advantages of "LT" CARTRIDGES in New Phonograph Engineering



Model "LT3-M"
Stamped Aluminum
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Model "LT2-M"
Stamped Steel
Wgt. 20 Grams

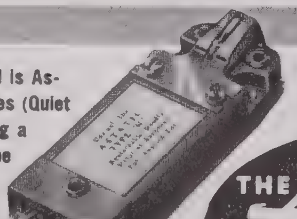
Model "LT1-M"
Die Cast Housing
Wgt. 28 Grams

LOW NEEDLE TALK, Low Needle Pressure and Low Price combine to make Astatic's new "LT" Series Cartridges particularly desirable for new installations in all types of automatic record changers and manually operated phonographs. Now available with stamped steel and aluminum as well as die cast housings, "LT" Cartridges may be selected in the proper weight to provide optimum needle pressure and pickup inertia characteristics with various types of arms.

The response of these cartridges is exceptionally smooth over the entire frequency range from 50 to 10,000 c.p.s., with a gradual roll-off commencing at approximately 4,000 c.p.s. Minimum Needle Pressure, ¾ oz. Output Voltage, 1.0 Volt average at 1,000 c.p.s.

All models in the "LT" Cartridge employ Astatic's replaceable, Type "T" stainless steel Needle with electroformed precious metal tip.

Also highly recommended is Astatic's de luxe "QT" Series (Quiet Talk) Cartridge, employing a matched, replaceable Type "Q" Needle with sapphire or precious metal tip.



Literature is Available

THE Astatic CORPORATION
CONNEAUT, OHIO
IN CANADA, CANADIAN ASTATIC LTD., TORONTO, ONTARIO
Astatic Crystal Devices Manufactured under Brush Development Co. patents

SECTION MEETINGS

ATLANTA

"Operation of Pentagrid Frequency Converters," by W. T. Clary, Georgia School of Technology; January 17, 1948.

BOSTON

"Electrical Flash Sources for Color Photography," by H. E. Edgerton, Massachusetts Institute of Technology; January 22, 1948.

BUENOS AIRES

"The Engineer and his Relation to Economic Problems," by W. Klappenbach, Engineer; December 5, 1947.

"Rules and Regulations on Radiocommunications," by A. T. Cosentino, Pan American Argentina; December 19, 1947.

BUFFALO-NIAGARA

"Electronics in Miniature," by C. Brunetti, National Bureau of Standards; January 21, 1948.

CEDAR RAPIDS

"Two-Way Communications for Taxi Cabs," By W. L. Cunningham, Bendix Radio Company; January 21, 1948.

Election of Officers; January 21, 1948.

"Methods and Procedures in Power Tube Development," by W. H. Kohl and J. W. Clark, Collins Radio Company; February 11, 1948.

CHICAGO

"Some Equipment and Systems Aspects of Emergency Radio Communications," by L. P. Morris, Motorola, Inc.; January 16, 1948.

"Equipment and Allocation Problems in Maximum Frequency Spectrum Utilization for Mobile Radio Telephone Services," by D. E. Noble, Motorola, Inc.; January 16, 1948.

CINCINNATI SECTION

"Very-High-Frequency Tuner Design," by G. Wallin and C. W. Dymond, Motorola, Inc.; January 20, 1948.

CLEVELAND

"Science, Engineering, and Society," by G. F. Leydorf, Radio Station WJR; January 22, 1948.

COLUMBUS

"Seam Deflection Mixer Tubes for Ultra-High Frequencies," by E. W. Herold, Radio Corporation of America; November 19, 1947.

"Infrared and Its Relation to the Radio Spectrum," by E. Bell, Ohio State University; January 9, 1948.

DALLAS-FORT WORTH

Election of Officers; January 16, 1948.

"Waveguide Bridge Circuits," by C. F. Crandell, Southwestern Bell Telephone Company; February 12, 1948.

DES MOINES-AMES

"Voice of America—Transmitters of OWI," by J. L. Hollis, Collins Radio Company; January 28, 1948.

Election of Officers; January 28, 1948.

EMPORIUM

"Nucleonics and Electronics," by H. W. Parker, Sylvania Electric Products Inc.; December 8, 1947.

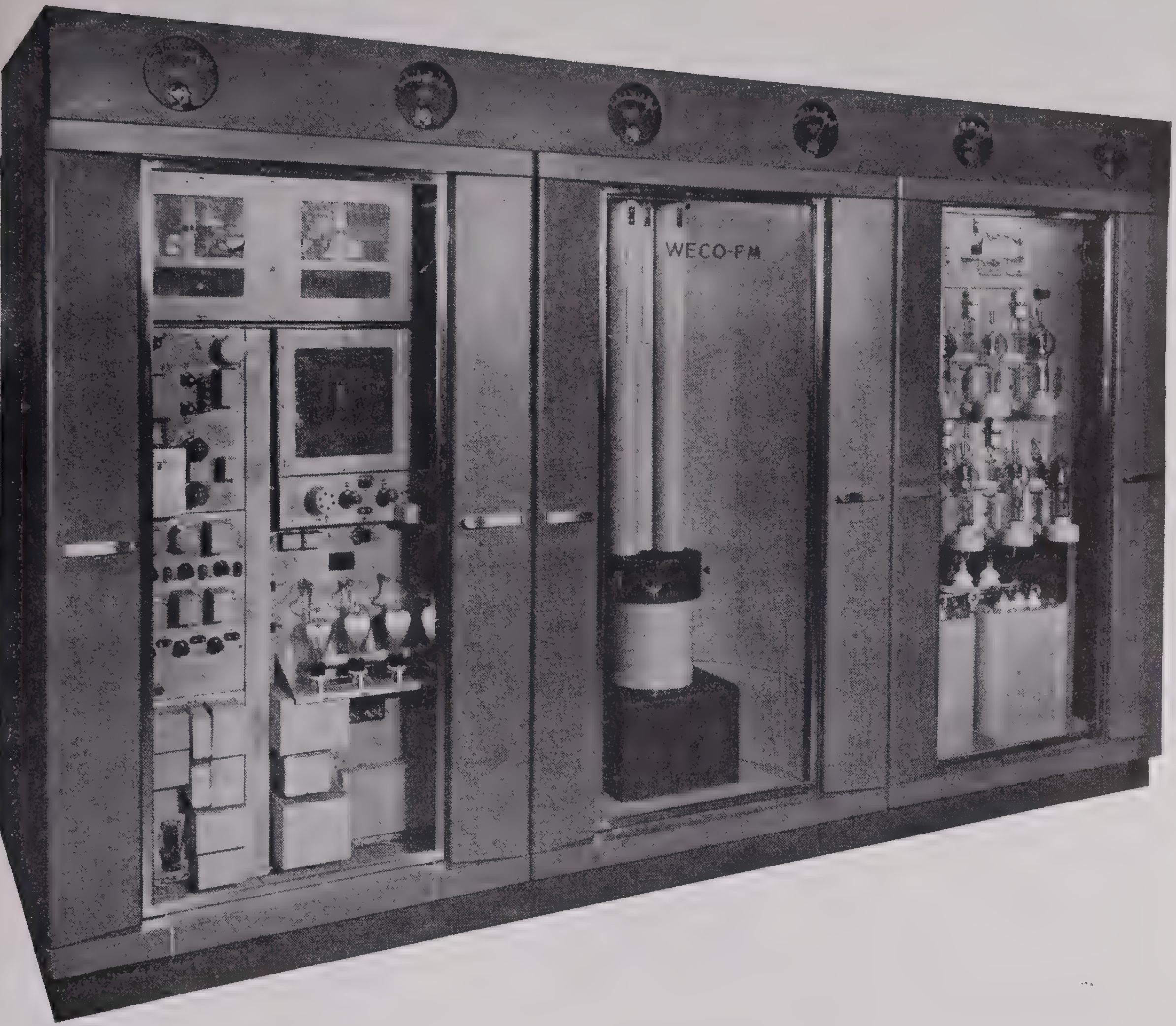
HOUSTON

"New Types of Capacitors and Resistors for Electronic Apparatus—The Practical Results of Wartime Research," by L. Podolsky, Sprague Electric Company; November 14, 1947.

"Engineering Problems in Mobile Radio-Telephony in Texas," by J. D. Mathis, Southwestern Bell Telephone Company; December 15, 1947.

(Continued on page 36A)

You get two complete transmitters . . .



. . . when you buy the Western Electric 10KW FM!

In this 10 kw transmitter the 1 kw driver is your standby equipment. If your final amplifier or its power supply should fail, a simple operation (taking less than a minute) puts you back on the air—with the driver itself as your emergency transmitter!

This Western Electric feature gives you still another safeguard against off-the-air time. If your main source of power fails, your emergency power source may be too small to handle a 10 kw transmitter. In that case, just cut back to 1 kw operation!

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SECTION MEETINGS

(Continued from page 34A)

"Solution of Transmission Line Problems by Graphical Methods," by C. Wischmeyer, Rice Institute; January 15, 1948.

"The Applications of Inverse Feedback," by L. W. Erath, Schlumberger Well Surveying Corporation; February 16, 1948.

INDIANAPOLIS

"Network Broadcasting," by E. C. Belzer Indiana Bell Telephone Company; December 19, 1947.

"Microphones," by C. M. Chorpening, Astatic Corporation; January 23, 1948.

LONDON (ONTARIO)

"Some Practical Engineering Factors to be Considered in Planning a Radio Communication Service," by P. Field, Station CFPL; January 30, 1948.

"Frequency Modulation," by B. Graham, Sparton of Canada Ltd.; January 9, 1948.

LOS ANGELES

"The Design of Self-Excited Oscillators for Cyclotrons," by J. Backus, University of Southern California; January 20, 1948.

"The Use of Plasma Sheaths as Variable Condensers," by W. Parkins, University of Southern California; January 20, 1948.

NEW YORK

"New Techniques in Waveguides—Special Waveguide Systems of Extreme Bandwidth," by F. J. Gaffney, Polytechnic Research and Development Corporation; January 22, 1948.

"A Nonreflecting Branching Filter for Microwaves," by W. D. Lewis and L. C. Tillotson, Bell Telephone Laboratories; January 22, 1948.

"Field Patterns of Aircraft Antenna," by D. F. Bowman, Airborne Instruments Laboratory; February 4, 1948.

OTTAWA

"Ultrasonics and Their Application," by T. D. Northwood, National Research Council; January 8, 1948.

"The Use of Directional Antennas for Broadcasting in the Standard Band," by K. A. MacKinnon, Consulting Radio Engineer; January 29, 1948.

PHILADELPHIA

"New York-Boston Relay System," by G. N. Thayer, Bell Telephone Laboratories; February 4, 1948.

PITTSBURGH

"Frequency-Modulation Detectors," by S. W. Seeley, RCA Laboratories; February 9, 1948.

PORTLAND

"An Analysis of the Intermodulation Method of Distortion Measurement," by W. N. Eldred, Hewlett-Packard Company; February 4, 1948.

"The Use and Adjustment of Feedback in A.M. Transmitters," by J. C. Herber, Western Electric Company; February 13, 1948.

PRINCETON

"The Baldwin Electronic Organ," by J. F. Jordan, The Baldwin Company; February 12, 1948.

ROCHESTER

"The New Cyclotron at the University of Rochester," by S. W. Barnes, University of Rochester; January 22, 1948.

"Applications of the Cathode-Ray Oscillograph in Industry," by E. G. Nichols, Allen B. Du-Mont Laboratories; February 5, 1948.

ST. LOUIS

"Use of Radio in Providing Telephone Service," by H. P. Lawther, Southwestern Bell Telephone Company; January 22, 1948.

(Continued on page 38A)

SYLVANIA RESEARCH NEWS

APRIL *Prepared by* SYLVANIA ELECTRIC PRODUCTS INC., Bayside, L. I. 1948

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SECTION MEETINGS

(Continued from page 36A)

San Diego

"Development of Ground-Controlled Approach System," by K. Mealey, Consolidated-Vultee Aircraft Corporation; February 3, 1948.

San Francisco

"An Experimental Television Studio," by F. R. Brace, Consulting Engineer; January 14, 1948.

"A Zero- to 200-Mc. Video Amplifier Using Conventional Tubes," by J. Noe, Hewlett-Packard Company; February 4, 1948.

Seattle

"An Analysis of the Intermodulation Method of Distortion Measurement," by W. N. Eldred, Hewlett-Packard Company; February 5, 1948.

Syracuse

"Nucleonics," by W. R. G. Baker, General Electric Company; February 5, 1948.

"Seeing with Echoes," by F. Slaymaker, Stromberg-Carlson Company; February 16, 1948.

Twin Cities

"Three Dimensional Presentation of Data on Cathode-Ray Oscilloscopes," by O. Schmidt, University of Minnesota; January 29, 1948.

Washington

"Printed Circuits and Miniature Electronics," by C. Brunetti, National Bureau of Standards; February 9, 1948.

SUB-SECTIONS

Lancaster

"The Teleran Air Navigation and Traffic Control System," by D. H. Ewing, Radio Corporation of America; February 11, 1948.

Northern New Jersey

"Two-Signal Performance of Some F.M. Receiver Systems," by B. D. Loughlin, Hazeltine Laboratories; January 14, 1948.

STUDENT BRANCH MEETINGS

University of Arkansas, I.R.E. Branch

"Obtaining Federal Communications Licenses," by B. A. Vizzier, Student; February 4, 1948.

Election of Officers; February 4, 1948.

Alabama Polytechnic Institute, I.R.E. Branch

"Microwave Towers and Carbon in Telephones," by H. W. Stephens, Southern Bell Telephone Company; February 16, 1948.

Election of Officers; February 17, 1948.

University of Illinois, I.R.E.-A.I.E.E. Branch

"A Good Man is Hard to Find," by G. D. Lobinger, Westinghouse Electric Company; January 22, 1948.

Election of Officers; January 22, 1948.

(Continued on page 40A)

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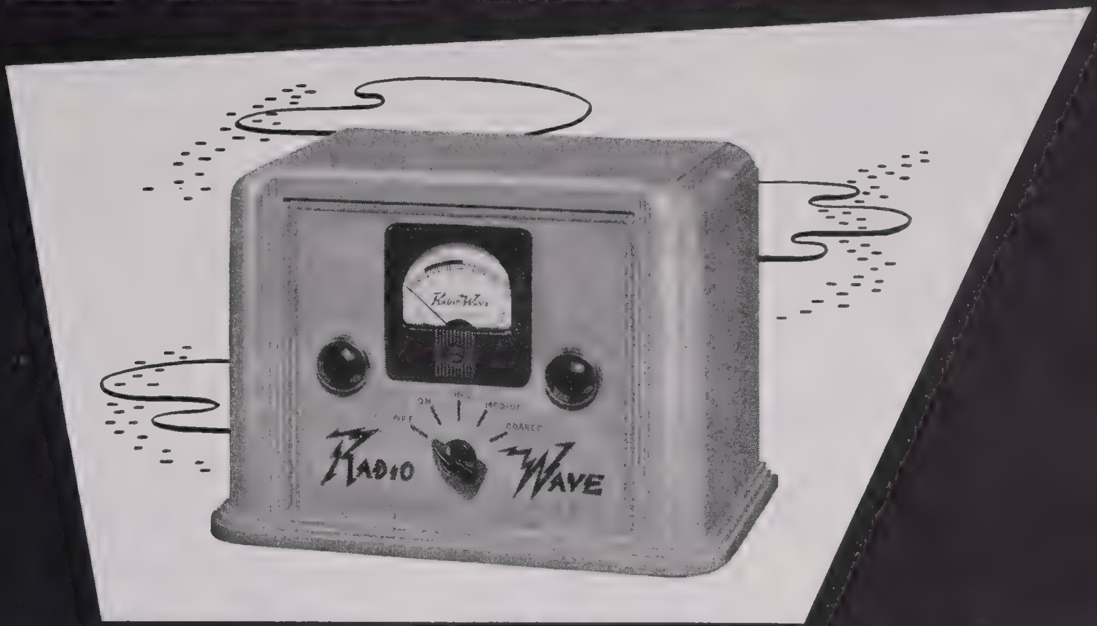

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STUDENT BRANCH MEETINGS

(Continued from page 38A)

KANSAS STATE COLLEGE, I.R.E. BRANCH

"Industries and Job Opportunities," by L. S. Hobson, Kansas State College; February 4, 1948.

THE COLLEGE OF THE CITY OF NEW YORK, I.R.E. BRANCH

"High-Voltage Pulse Power Supplies," by P. J. Reich, North American Phillips Corporation; December 16, 1947.

Election of Officers; January 6, 1948.

NORTH CAROLINA STATE COLLEGE, I.R.E. BRANCH

"Audio Systems," by D. K. Briggs, Western Electric Company; January 26, 1948.

STANFORD UNIVERSITY, I.R.E.-A.I.E.E. BRANCH

"Mathematics in the Making," by G. Polya, Stanford University; January 28, 1948.

UNIVERSITY OF TEXAS, I.R.E.-A.I.E.E. BRANCH

Election of Officers; January 12, 1948.

"Insurance Liabilities as Related to Industry," by D. Whiffen, State Insurance Board; February 16, 1948.

UNIVERSITY OF UTAH, I.R.E.-A.I.E.E. BRANCH

"Power Distribution Problems in Utah Valley," by W. Clark, Utah Valley Power Company; January 27, 1948.

"The Westinghouse Training Program," by S. M. Johns, Westinghouse Electric Corporation; February 3, 1948.

"Construction of the Boulder Dam," a film prepared and distributed under the direction of the United States Bureau of Reclamation; February 10, 1948.

UNIVERSITY OF WASHINGTON, I.R.E.-A.I.E.E. BRANCH

"Professional Society Affiliation," by R. E. Kistler, Pacific Telephone & Telegraph; January 16, 1948.

Election of Officers; January 16, 1948.

MEMBERSHIP

The following transfers and admissions were approved on March 2, 1948, to be effective as of April 1, 1948:

Transfer to Senior Member

Albrecht, A. P., 4260 Stillwell Ave., Los Angeles, Calif.
Blom, B. V., 38 Lafayette St., Rumson, N. J.
Butterworth, J. W., 36 Katz Ave., Paterson, N. J.
Cox, C. R., 1661 W. 105 St., Chicago 43, Ill.
Early, H. C., 165 Stein Rd., Ann Arbor, Mich.
Field, G. S., 53 Fentiman Ave., Ottawa, Ont., Canada
Greibach, E. H., 80 Pryer Terr., New Rochelle, N. Y.
Martel, C. W., 3 Sunny Knoll Ave., Lexington 73, Mass.
Miller, A. C., 213 Buttonwood Way, Glenside, Pa.
Miller, H. R., 217 Tennessee Ave., N.E., Washington, D. C.
Osterland, E. H., Mountain Lakes, N. J.
Rogers, G. F., 129 Moore St., New Hyde Park, L. I., N. Y.

(Continued on page 42A)

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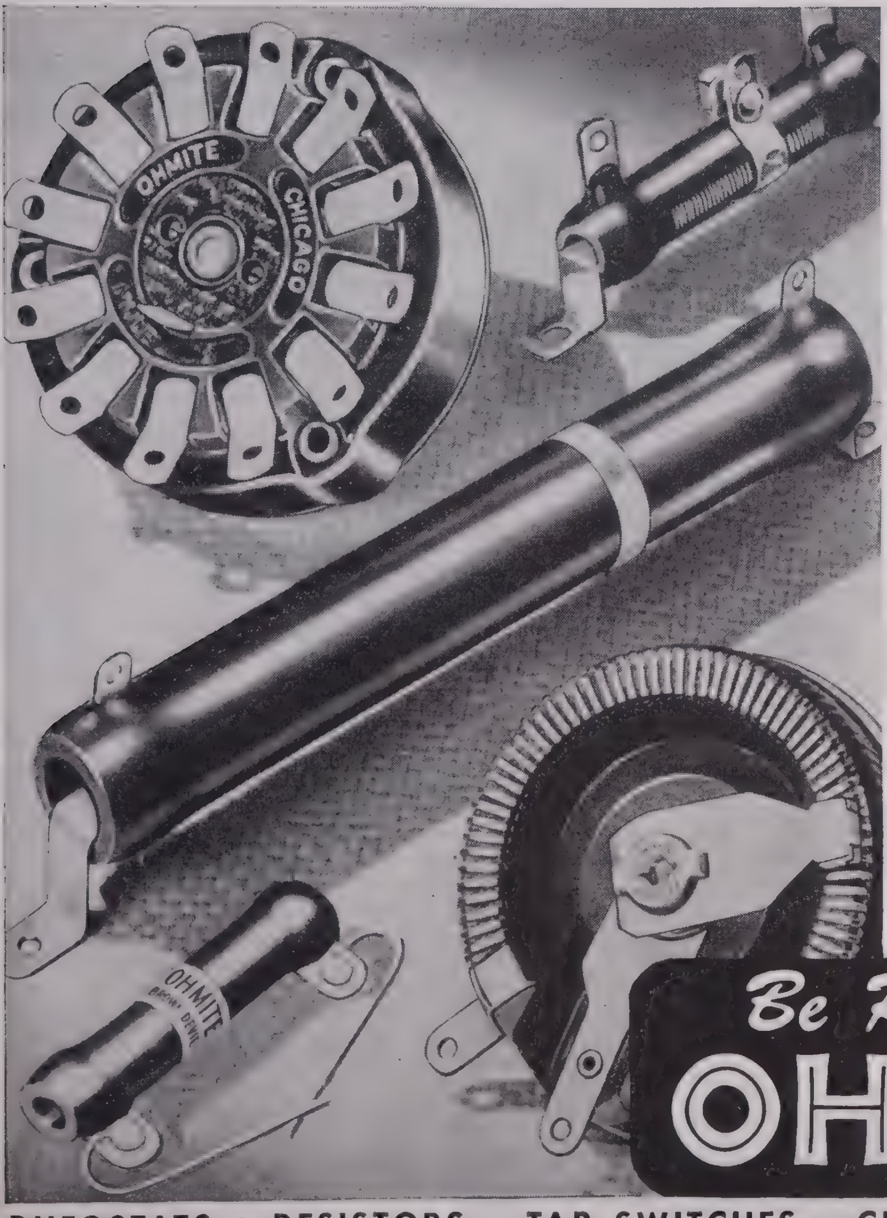

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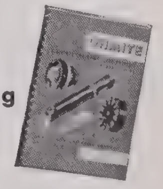

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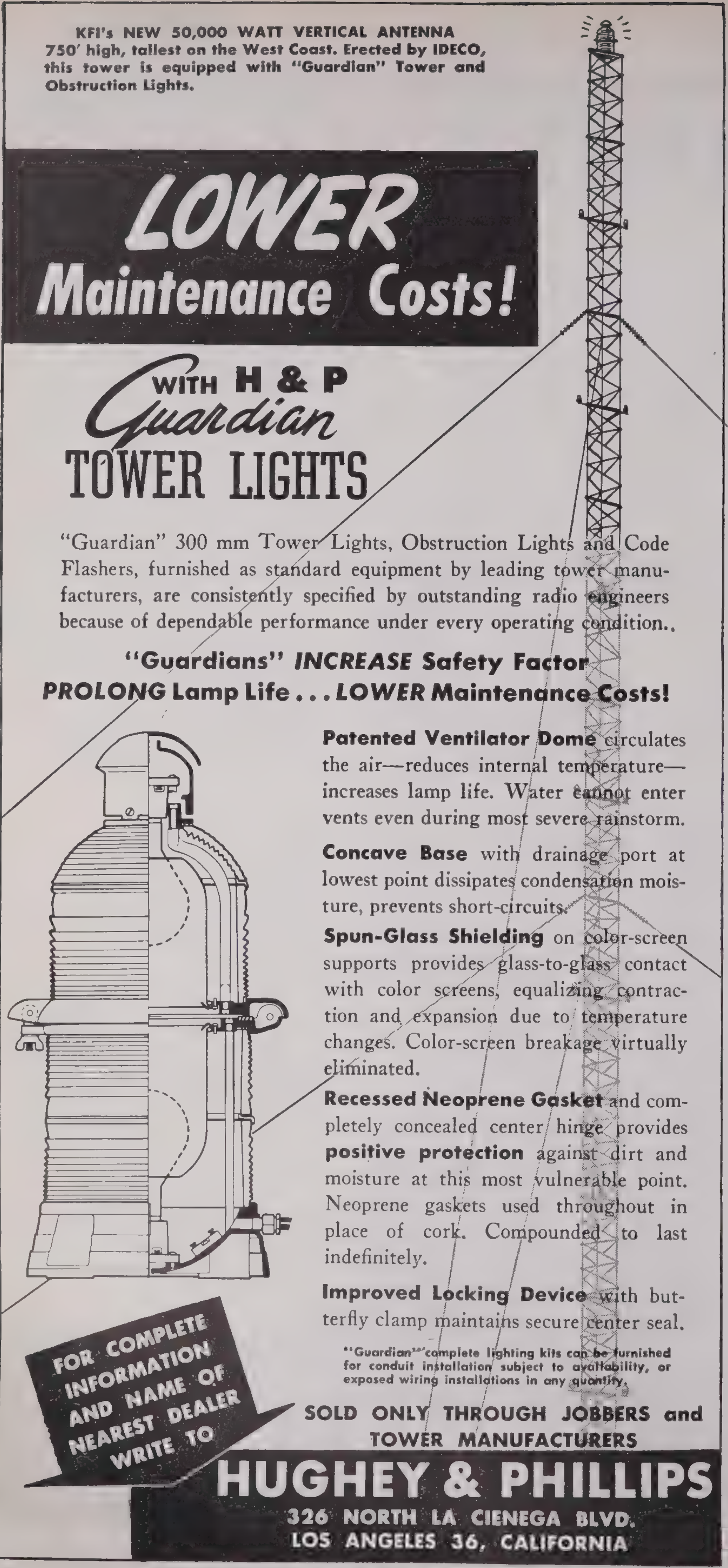

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(Continued from page 40A)

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Thompson, LeRoy, Jr., 526–18 St. So., Arlington, Va.
Young, L. G., Bell Telephone Laboratories, Inc., Deal, N. J.

Admission to Senior Member

Ahmad, Riaz, ATCI Bldg., Willingdon Airport, New Delhi, India.
Belock, H. D., c/o Reeves Instrument Corporation, 215 E. 91 St., New York, N. Y.
Fife, S. T., University of Louisville, Louisville 8, Ky.
Fink, L. R., 1149 Millington Rd., Schenectady 8, N. Y.
Lundstrom, A. A., 62 Fernwood Rd., East Orange, N. J.
MacWilliams, W. H., Jr., Bell Telephone Laboratories, Inc., Whippany, N. J.
Smyth, H. R., 36 Kinnear St., Ottawa, Ont., Canada
Trott, B. S., c/o Garod Radio Corporation, 70 Washington St., Brooklyn 1, N. Y.
Wagner, S. J., 486 South Main St., Bradford, Mass.

Transfer to Member Grade

Bagg, T. C., National Bureau of Standards, Washington, D. C.
Burke, A. T., 3306 Mission Blvd., San Diego 8, Calif.
Cameron, J. A., 129 Eddywood St., Springfield 8, Mass.
Davis, W. C., 3007 Neil Ave., Columbus, Ohio
Dettman, M. C., 9527 Glenwood Rd., Brooklyn 12, N. Y.
Egenes, O. K., c/o Wireless Station, Klipheuwel, South Africa
Ellis, W. C., 5648 East Side, Dallas 14, Tex.
Goodyear, W. F., 104 Cherrydell Rd., Baltimore, Md.
Greer, P. A., 17 Spears Ave., Asheville, N. C.
Hart, W. E., 616 Mt. Zoar St., Elmira, N. Y.
Hedrich, A. L., 3712 Second St., S.E., Washington, D. C.
Horwitz, S. J., 4731 West Schubert Ave., Chicago, Ill.
Kahgan, J. J., 78 Eighth Ave., Brooklyn 15, N. Y.
Kelk, G. F., 477 Bayview Ave., Toronto, Ont., Canada
Littell, C. C., Jr., 222 Lonsdale Ave., Dayton 9, Ohio
Marshall, F. M., 4280 South 35 St., Arlington, Va.
May, J. C., Dunham Laboratory, Yale University, New Haven, Conn.
Mayer, R. H., 2728 Brentwood, St. Louis 17, Mo.
Ogg, R. D., 670 Creston Rd., Berkeley 8, Calif.
Pettengill, G. W., 421 Taylor Ave., W. Collingswood, N. J.
Rasley, D. R., Farnsworth Television and Radio Corporation, Fort Wayne 1, Ind.
Smith, C. A., 22 Flower Lane, Roslyn Heights, N. Y.
Wadham, C. W., Patent Office, Lambton Quay, Wellington, New Zealand
Walters, LeRoy, 8217 Schrider St., Silver Spring, Md.
Ward, J. W., 36 Marion St., Forestville, Conn.
Weiss, W. I., Sr., 99 Livingston St., Brooklyn, N. Y.
Williams, R. E., 23 Roberts Court West, Portsmouth, Va.
Winzemer, A. M., 265 Newcomb St., S.E., Washington 20, D. C.
Yoder, J. R., 12 Wenzel Terr., Stanford, Conn.

Admission to Member Grade

Brown, H. B., 1733 Vermont St., Lawrence, Kan.
Coleman, E. F., 333 E. 43 St., New York 17, N. Y.
Davidson, G. K., 517 Golden Ave., Ottawa, Ont., Canada

(Continued on page 44A)

Wireless World
RADIO AND ELECTRONICS
WIRELESS ENGINEER
AUGUST 1947

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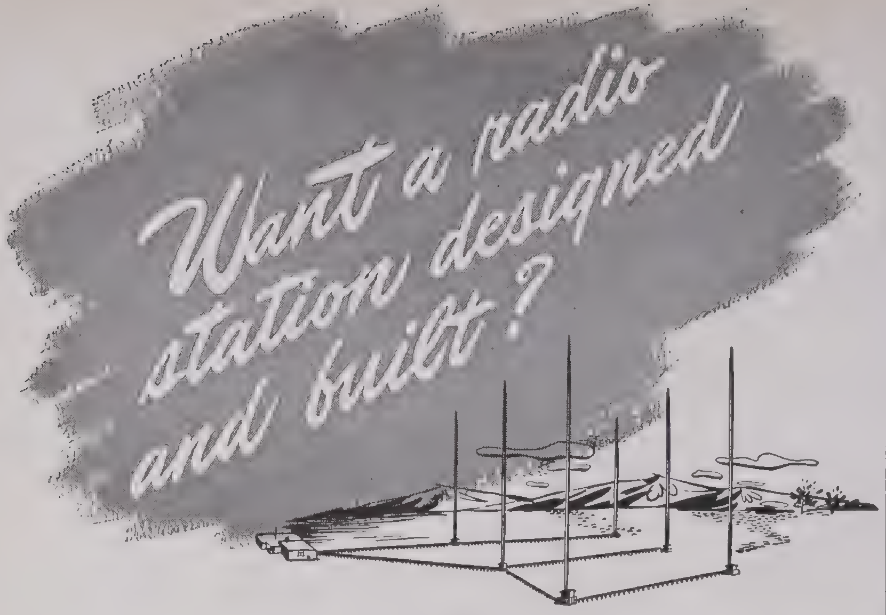
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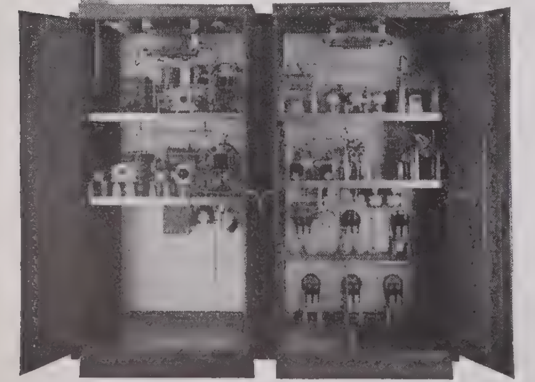
In particular we wish to thank Mr. Walt Kean of the Andrew Broadcast Consulting Division who was responsible for conceiving and designing the installation, supervising construction of all antenna equipment, and doing the final tuning and coverage surveys."



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MEMBERSHIP

(Continued from page 42A)

Fuller, C. M., Box 73, Hato Rey, P. R.
Gade, C. P., 825 Westcott St., Syracuse 10, N. Y.
Greer, W. R., 7772 Signal Group, APO 757, c/o Postmaster, New York, N. Y.
Grimm, A. C., RCA Victor Division, Lancaster, Pa.
Gulden, W. W., 3154 Brackenwoods Lane, Cincinnati, Ohio
Halligey, P., 8, Princes Gardens, London, W. 5, England
Hill, L. P., Headquarters Air Materiél Command, Box 1362, Wright Field, Dayton, Ohio
Jahrling, R. J., c/o Premier Crystal Laboratories, Inc., 53–63 Park Row, New York 7, N. Y.
Johnson, W. R., 141 N. Vermont, Los Angeles 4, Calif.
Jones, J. D., 617 Seventh Ave., Asbury Park, N. J.
Kriegel, H. C., Box 346, Wharton, Tex.
Laub, R. E., 2367 North Quebec, Arlington, Va.
Martin, L. B., 196 Colorado St., Mattapan, Mass.
Matthews, R. B., 1736 Church St., Wauwatosa, Wis.
McKirdy, R. W., 21 Ridgecrest East, Scarsdale, N. Y.
McLean, D. F., c/o Turnbull Elevator Company, Ltd., 126 John St., Toronto 2B, Ont., Canada
Mort, J., 42, Barn Lane, Golborne, Nr. Warrington, England
Nachtigall, S., 183 Ocean Parkway, Brooklyn 18, N. Y.
Newman, R. W., Bldg. 269, General Electric Company, Schenectady, N. Y.
North, C. W., 909 Elmwood, Evanston, Ill.
Nuttall, E. D., Box 1407, Shreveport, La.
Quirk, W. B., So. New England Telephone Company, 227 Church St., New Haven, Conn.
Rider, D. V., 10 East 40, Kansas City 3, Mo.
Ryan, H. J., Gen. Del. Box 107, Haskell, N. J.
Sutton, R. A., 1734 Wroxton Ct., Houston 5, Tex.
Tucker, S. A., 620 W. 149 St., New York 31, N. Y.
Warner, D. F., 715 Grand Ave., Syracuse, N. Y.
Worne, B. E., 64 Pierson Rd. South, Maplewood, N. J.
Zetekoff, A., 326 Lincoln Pl., Brooklyn, N. Y.

The following admissions to Associate were approved on March 2, 1948, to be effective as of April 1, 1948:

Abell, C. W., 3561—92 St., Jackson Heights, L. I., N. Y.
Aberer, J. C., 215 East North Ave., Elmhurst, Ill.
Anderson, S. E., 1 Napoleon St., Valparaiso, Ind.
Angwin, B. S., 238 N. Frederic St., Burbank, Calif.
Arbo, O., Peru 165, Buenos Aires, Argentina
Barkley, M. M., Sunrise Ave., Trotwood, Ohio
Barrera, J., San Martin 379, Buenos Aires, Argentina
Bay, R. J., R.F.D. 1, Elmore, Ohio
Bedal, G. K., 18 Everett St., Belleville, Ont., Canada
Bernardi, A. R., 25 Oakwood Ave., White Plains, N. Y.
Berry, F. W., Joint Staff, Headquarters Alaskan Command, Ft. Richardson, Alaska
Blight, A. F., Jr., 7363 W. Manchester Blvd., Los Angeles 45, Calif.
Boyes, W. E., Sandia Base Branch Post Office, Albuquerque, N. Mex.
Burns, M. C., 335—21 St., Richmond, Calif.
Buttler, J. L., 203-B South John St., Angola, Ind.
Calobrisi, P. A., 8783—16 Ave., Brooklyn 14, N. Y.
Caprara, L., 900 West Maumee St., Angola, Ind.
Cavileer, F. E., 2812 North 9 St., Philadelphia 33, Pa.
Chaikin, M., 21 Schenck Ave., Great Neck, L. I., N. Y.
Church, R. W., 78–40—86 St., Glendale 27, N. Y.
Cohen, M., 1337 Randolph St., N.W., Washington 11, D. C.

(Continued on page 46A)

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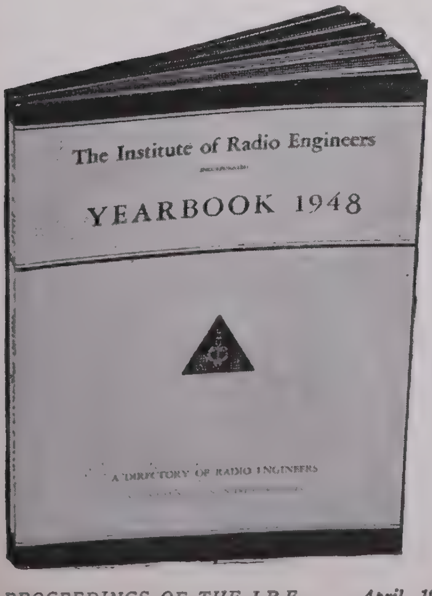
The Institute of Radio Engineers
YEARBOOK 1948
A DIRECTORY OF RADIO ENGINEERS

FEATURES

- Complete membership list of The Institute of Radio Engineers.
- An alphabetical list of over 2000 firms serving the radio-electronic industry, with addresses, and —
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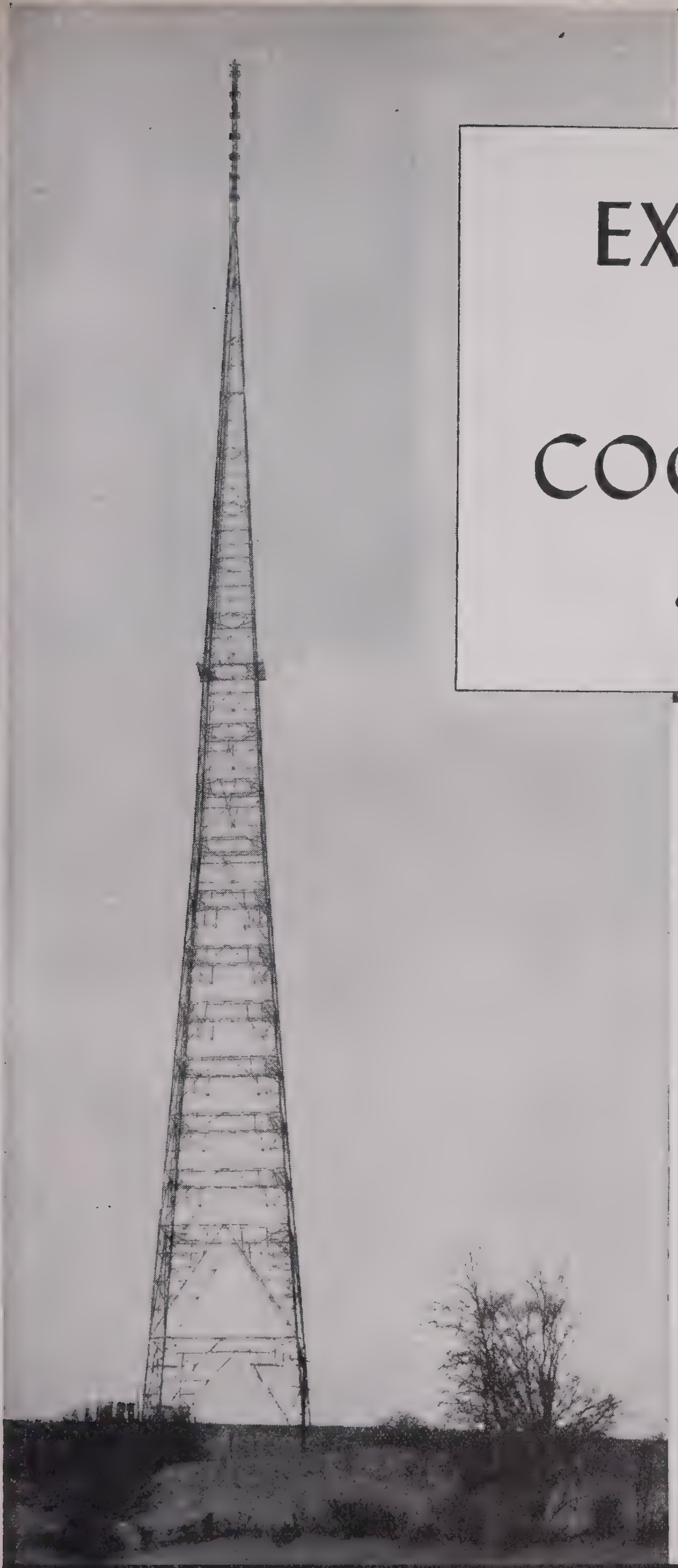

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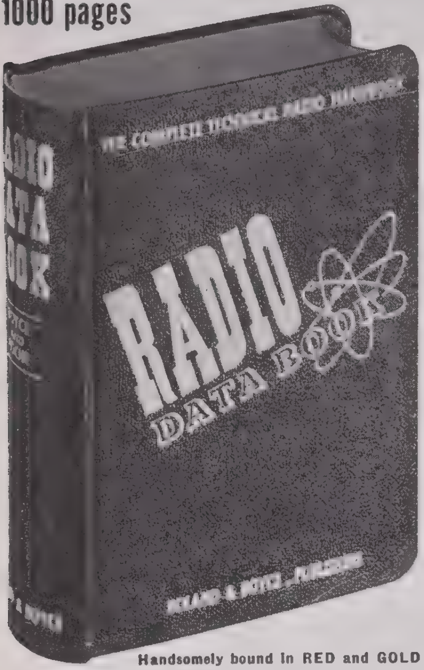
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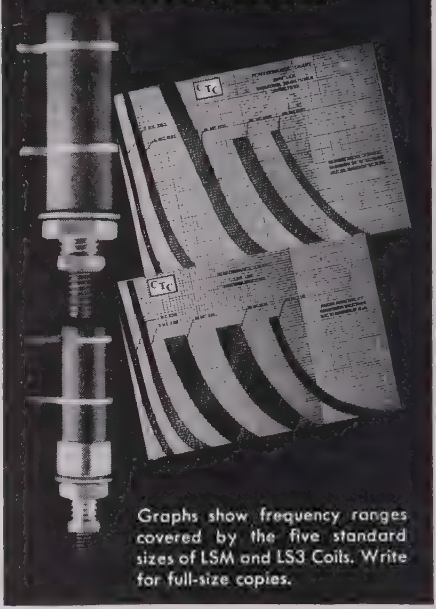

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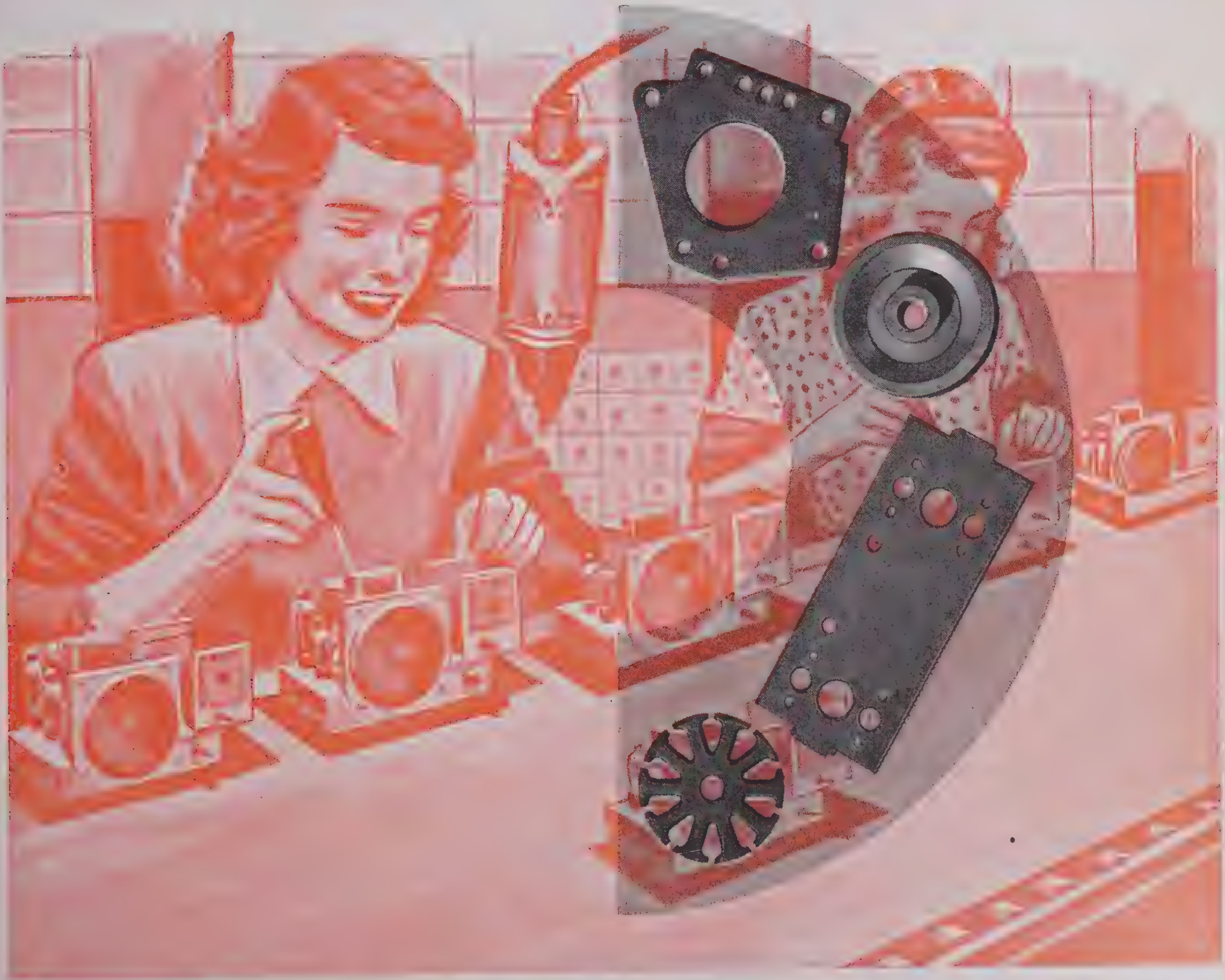

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(Continued on page 52A)

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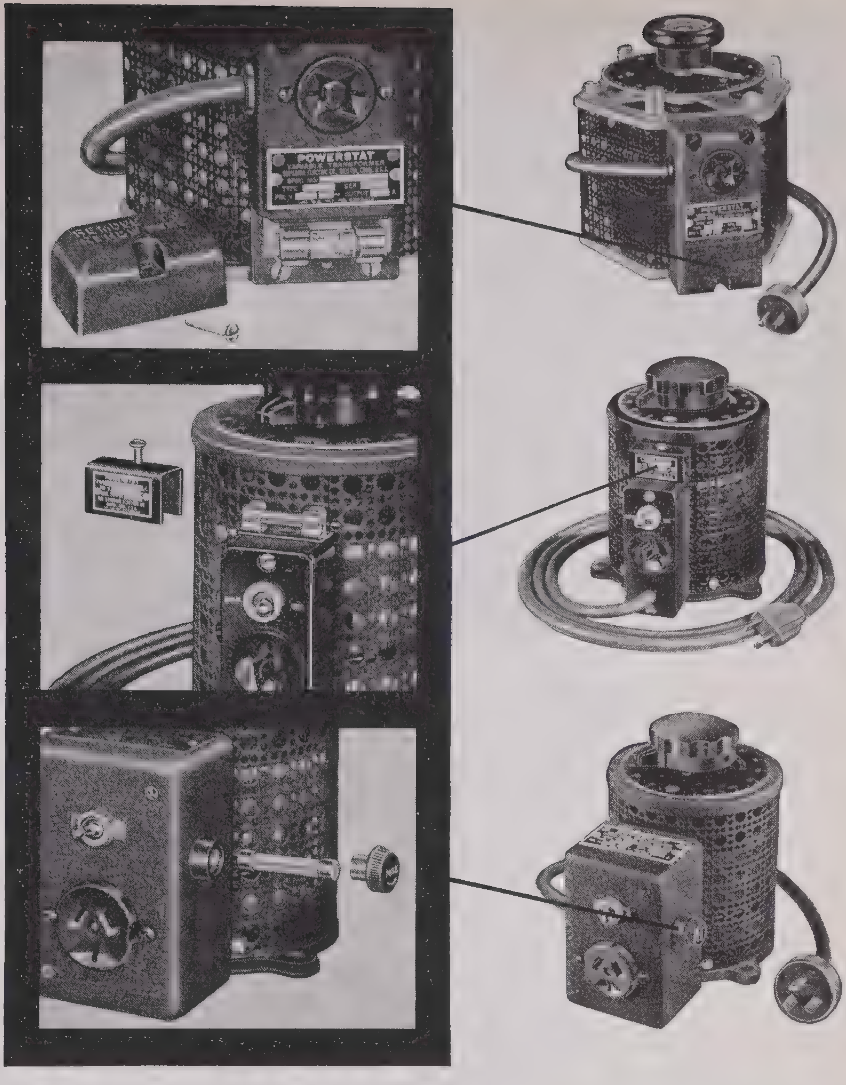

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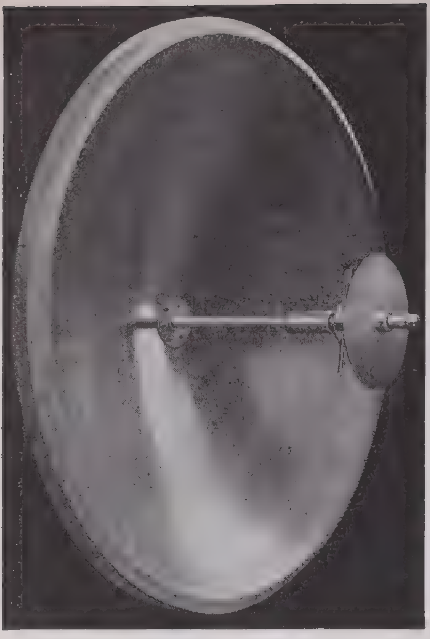

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(Continued from page 50A)

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Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or development experience on *radio communications systems, electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.*

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TO
EMPLOYMENT SECTION

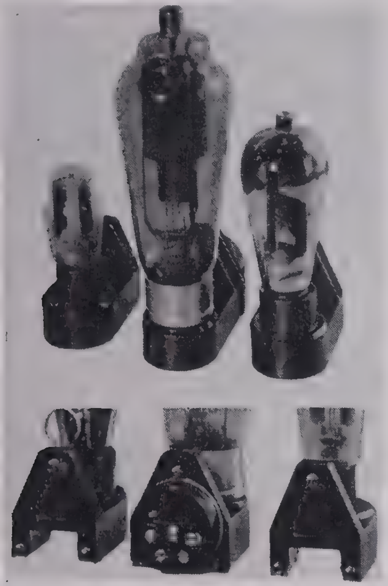
SPERRY GYROSCOPE
COMPANY, INC.
Marcus Ave. & Lakeville Rd.
Lake Success, L.I.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

New Tube Sockets

The **American Phenolic Corporation**, 1830 South Fifty-fourth Ave., Chicago 50, Ill., has developed three new tube sockets to meet the requirements for mounting industrial tubes on the face side of vertical control panels.



Conservation of floor space necessitates the design of many electronic control equipments into vertical arrangements. Previously, the equipment manufacturer has had to employ cumbersome box-like brackets on these vertical panels as supports for the tube sockets normally intended for application only on horizontal panels.

These new sockets of phenolic material are designed to meet NEMA requirements and feature high-conductivity cloverleaf contacts to insure very low contact reresistance at the tube base pins. Individually supported, these sockets permit spacing to allow convection air-current cooling of the tubes.

Omnidirectional Antenna

An omnidirectional antenna, Type 624, is announced by **Technical Appliance Corp.**, Sherburne, N. Y. This "S" folded dipole fills the need for a nondirectional horizontally polarized antenna for reception from several television or f.m. transmitters located at various points of the compass from the receiver. A new type of mounting clamp assures rigid construction. The bakelite terminal block also mounts a strain insulator for attaching the 300-ohm ribbon-type transmission line. A 5-foot mast is supplied for mounting the antenna above the roof. Screw eyes and other mounting hardware is supplied, as well as a 60-foot 300-ohm transmission line.

(Continued on page 58A)

DIALCO

PILOT LIGHT ASSEMBLIES

PLN SERIES—Designed for NE-51 Neon Lamp

Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
- 110 or 220 VOLTS
- EXTREME RUGGEDNESS
- VERY LOW CURRENT

Write for descriptive booklet

The DIAL LIGHT CO. of AMERICA
FOREMOST MANUFACTURER OF PILOT LIGHTS
900 BROADWAY, NEW YORK 3, N. Y.
Telephone—Spring 7-1300

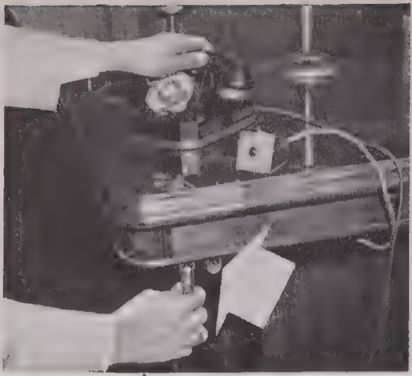
COMMUNICATIONS—ELECTRONICS—TELEVISION

for **DEPENDABLE** performance
FREED TRANSFORMERS

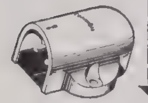
To meet rigid requirements for all industrial and electronic applications Freed has manufactured for many years all types of transformers, chokes, and reactors. In addition the manufacture of all types of production laboratory test equipment is a Freed specialty.

If you have special requirements or need custom made equipment, our modern plant and trained staff are always at your service.

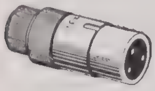
FREED TRANSFORMER CO., Inc.
78 SPRING STREET NEW YORK CITY 12, N. Y.



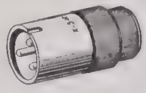
"X" MARKS THE SPOT



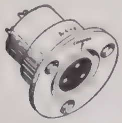
. . . where the X-3-42 Receptacle *(shown just above)* unobstrusively reposes underneath the table top so that the intercommunication phone may be moved around the executive conference table. The Type "X" Series is particularly adapted to plug-in intercom systems such as shown above, and is also widely used in sound service, instruments, radio and public address systems. Two plug and 3 receptacle types are available with 3 different insert arrangements (interchangeable): one 15-amp.; three 15-amp.; and three 10-amp. and one 15-amp. contacts. Shells are diecast zinc with bright nickel finish, and have accommodation for 3/16" to 9/32" cable. Friction engagement. Available direct from more than 225 distributors over the U.S.A. or from factory.



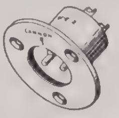
X-3-11 Plug
$1.75 List



X-3-12 Plug
$1.25 List



X-3-13 Receptacle
$1.75 List



X-3-14 Receptacle
$1.25 List

Listed and priced in the RJC-2 and C-47 Condensed Catalogs. Engineering drawings of the "X" in P&O Bulletin. Specify bulletin desired. Address Dept. D-377.

SINCE 1915

CANNON
ELECTRIC
Development Company

3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.
IN CANADA & BRITISH EMPIRE:
CANNON ELECTRIC CO., LTD., TORONTO 13, ONT.
WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

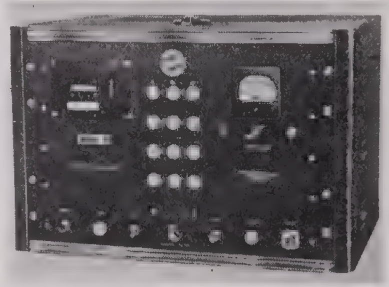
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 57A)

Decade Scaler for Radiation Measurements

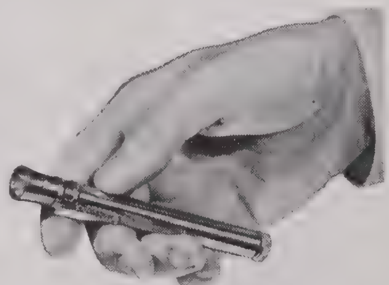
Designed specifically for radioactivity measurements, the new Model 2092 Decade Scaler is a completely self-contained instrument being produced by **Potter Instrument Co., Inc.,** 136–56 Roosevelt Ave., Flushing, N. Y.



This instrument includes an input sensitivity of 0.25 volt, three scale-of-10 counter decades, a four-digit mechanical register, control for a clock timer, and an adjustable high-voltage regulated power supply for the operation of Geiger-Mueller tubes.

The Decade Scaler will resolve two pulses which are 5 microseconds apart and will count continuously with accuracy at rates up to 130,000 counts per second.

Pocket Dosimeter



A new Model 3360 Pocket Dosimeter, which provides an easily read indication of the amount of radioactivity to which the carrier of the instrument has been exposed, is announced by **Instrument Development Laboratories,** 229 West Erie St., Chicago 10, Ill.

The dosimeter is for the use of scientific personnel who are associated with X-ray work or nuclear research, and can be read at any time by looking through the cupped eyepiece toward a light source. Thus it differs from the Model 3340 Meter, which can be read only on an electrostatic voltage indicator. In the new meter the observer sees a magnified scale upon which an indicating line shows, in milliroentgens, the amount of radiation to which the instrument has been exposed.

MICRODIMENSIONAL
WIRE & RIBBON
FOR VACUUM TUBES
Wires drawn to .0004" diameter.
Ribbon rolled to .0001" thickness.
Alloys for Special requirements.
SIGMUND COHN
NEW YORK

WRITE for list
of stock alloys.

SIGMUND COHN CORP.
44 GOLD ST., NEW YORK
SINCE 1901

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Frequency Monitor for Television Video Transmitters

For monitoring the frequencies of television video transmitters, the **General Radio Co.,** 275 Massachusetts Ave., Cambridge 39, Mass., announces the Type 1175-BT Frequency Monitor, to be used in conjunction with the Type 1176-A Frequency Meter. The monitor is designed for single-channel operation over a frequency range from 1600 kc. to 220 Mc. and the accuracy of monitoring is 0.001 per cent.

A low-pass filter eliminates the picture line frequency and allows a maximum frequency deviation of ±12 kc. to be monitored.

Monitor and frequency meter are in separate units, both designed for relay-rack mounting. Over-all panel dimensions for the complete assembly are 19 by 12¼ inches; depth behind panel is 11½ inches. Walnut end frames are available for adapting the assembly for table mounting. Net weight is 42 pounds.

New Tube Sockets

Electronic tube sockets for transmitting and industrial tubes have been made available by the Tube Division of the Electronics Department, **General Electric Co.,** Schenectady, N. Y.

Available in a wide range of sizes, the sockets include panel-mounted and chassis-mounted styles, and are built to NEMA specifications. The body of the sockets is molded in one piece from BM120 black bakelite with barriers for insulation and creepage paths.

Constructed from phosnic bronze, the socket's contacts are designed to be full floating with four lines of contact for the length of the whole pin. Each is removable and the spacing between leads and terminals is maintained at a maximum.

(Continued on page 60A)

ANOTHER TECH LAB FIRST!

NOW ON ALL ATTENUATORS AND POTENTIOMETERS

Silver Alloy Contacts

SILVER ALLOY
INSULATION
COPPER RIVET

New Silver Alloy contacts make possible improved Attenuators and Switches in smaller sizes.

1 Greater Creapage Distance—thus better insulation.
2 No silver migration.
3 Greater silver surface to carry current.
4 Lower contact resistance.
5 Better mechanical operation of switch.
6 Less capacity between contacts—better frequency characteristics.
7 Better clearance to ground.

TYPE 800 UNIT
with new contacts

TECH LABORATORIES, INC.

Manufacturers of Precision Electrical Resistance Instruments

337 CENTRAL AVE. • JERSEY CITY 7, N. J.

RH-9

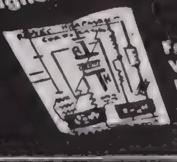
12 TO 75 MC.

VHF HARMONIC MODE CRYSTAL UNITS

REEVES-HOFFMAN CORP.

These frequencies can be generated with RH-9 in a one-tube oscillator circuit, operating in 3rd, 5th, or 7th mechanical mode.

Frequencies can be multiplied to higher frequencies as desired.



For RH-9 Specifications Write for Bulletin RHC-4

REEVES-HOFFMAN CORPORATION
CHERRY and NORTH STREETS • CARLISLE, PA.

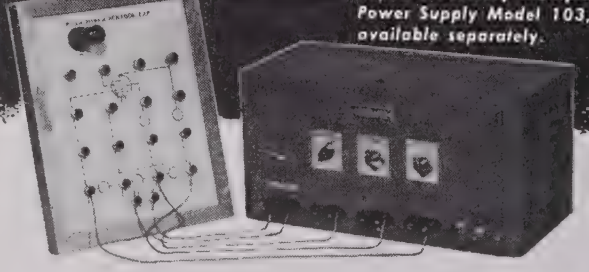
Sign of Transformer Reliability

KENYON For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!

Consult KENYON about your transformer problems.

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

NOW! SELF-CONTAINED, EXPERIMENTAL SCHOOL & INDUSTRIAL LAB EQUIPMENT



Kepco Laboratory Multiple Power Supply Model 103, available separately.

Kepco Electronic Instruction Panel Model 104, available separately.

Now you can perform electronic experiments simply, easily with the Kepco Electronic Instruction Panel. Here is a teaching aid that graphically illustrates vacuum tube principles—enables all students to grasp fundamentals in the laboratory.

Extremely versatile, the Kepco Electronic Instruction panel covers a wide range of tubes, comes with a packet of 23 keyed interchangeable circuit charts, 3 master charts and 12 blank keyed sheets for additional experiments. Panel contains 3 octal tube sockets, 18 binding posts. By placing a keyed circuit diagram on the panel and wiring the circuit, students determine tube and circuit characteristics.

For a basic electronic instructional aid that vastly simplifies the teacher's task, it's the Kepco Electronic Instruction Panel!

Now you can eliminate the use of cumbersome separate voltage supplies with the Kepco Laboratory Multiple Power Supply. Designed to be used with the Kepco Electronic Instruction Panel, this versatile, compact, easy-to-use unit supplies four commonly used voltages, is invaluable for the school or industrial laboratory.

CHECK THESE FEATURES:

Two continuously variable B supplies, adjustable from 0-300 volts at 120 m.a.
Variable (grid) supply, adjustable from minus 50 to plus 50 volts at 5 m.a.
6.3 volt filament supply at 5 amperes.
All connections made to sturdy, front panel binding posts.
Input: 105 to 125 volts, 50 to 60 cycles.
Two 5Y3 rectifiers, Two 6Y6 control tubes.
16" long, 8" high, 8¾" deep. Wgt.: 28 lbs.

WRITE FOR FULL INFORMATION TODAY!

Kepco · LABORATORIES INC. Electronic Instruments

142-45 Roosevelt Avenue
Flushing, New York

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

Regulated Power Supply

The **Atomic Instrument Co.,** 200 Charles St., Boston 14, Mass., has announced a compact power supply designed for use wherever a 500- to 2000-volt source of regulated high voltage at low current is required.

Typical applications for which this unit is particularly suited include Geiger-Mueller counters, electron-multiplier tubes, and cathode-ray tubes, as well as for general laboratory use. The supply delivers 500 μa. at 2000 volts and 1 ma. for voltages up to 1500. Regulation is maintained within 1% for ±10% line-voltage variations and load variations up to maximum rated load. At any voltage setting the drift is within 0.1%. An illuminated 3-inch meter indicates the output voltage to an accuracy of better than 5%.

Voltage step-up, rectification, and filtering are carried out at radio frequencies. This makes possible the use of very small capacitors which insure safety. Six miniature tubes are used, and the complete unit is housed in an oak cabinet measuring 7½ inches high by 12 inches wide by 5½ inches deep, and weighing 9½ pounds.

New Swivel Television Screen

A departure from the television receivers on the market today is the new Hollywood model being produced by the **Cleervue Television Corp.,** 81 Willoughby St., Brooklyn 1, N. Y.

The 12-inch direct-view swivel screen can be focused 180 degrees in any direction. Another feature of this receiver is its five-deck chassis construction, which is virtually five separate instruments designed to reduce service problems to a minimum. Each of the five chassis sections is a plug-in unit which can be removed and replaced instantaneously.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Type TMC-187 Tubular Capacitor

TMC 187
.005 MFD
3500 VDC

Increasing the scope of their line of capacitors designed specifically for television applications, **Cornell-Dubilier Electric Corp.,** South Plainfield, N. J., has introduced the type TMC-187. This extremely compact tubular capacitor is made in a rating of 0.005 μfd., 3500 working volts d.c., with dimensions of 1 1/16 inches diameter by 1¾ inches long. It is available in both single and dual capacitances and other voltage ratings with small physical dimensions.

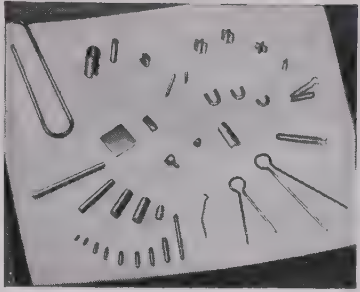
Type TMC-187 is housed in a hermetically sealed cylindrical metal container, and a wax-impregnated cardboard sleeve with rolled-over ends insulates the case. The capacitor is self-mounted on No. 18 solid tinned-copper wire leads.

New Selenium Rectifiers

Two models of selenium rectifiers for radio receivers and other electronic applications have been made available by the Tube Division of **General Electric Co.'s** Electronics Department at Schenectady, N. Y. Both models, 6RS 5GHI and 6RS 5GH2, are 1 inch square and have a high inverse-peak voltage rating with a low inverse current, even with peak voltages up to 350 volts. The latter type, ¼ inch shorter than the former, is recommended for limited-space applications.

Each rectifier will withstand safely the inverse peak voltages obtained when rectifying (half-wave) 100–125 volts r.m.s., and feeding a capacitor as required in various radio circuits. Ratings are based on ambient temperatures of 50° C. to 60° C.

(Continued on page 62A)



NEY Precious Metal Alloys *for*

ELECTRICAL CONTACTS ON POTENTIOMETERS SLIP RINGS, RELAYS AND SWITCHES

Standard Ney precious metal alloys with accurately defined properties are now available for prompt delivery in commercial quantities, and our Research Laboratory is ideally equipped to develop and test other special alloys to meet your rigid specifications.

PALINEY #7

SLIDING CONTACTS FOR POTENTIOMETERS

PALINEY #7 is being used for a contact material on potentiometers wound with a nickel-chrome alloy resistance wire. This combination is consistently producing units with life of better than one million cycles and maintained accuracy of 0.1% or better throughout the life of the unit.

NEY-ORO #28

SLIP RING BRUSHES

NEY-ORO #28 is a special alloy developed as a contact brush material for uses against coin silver slip rings. Laboratory tests and reports from users indicate life of better than 10 million revolutions with no electrical noise.

Write or telephone (Hartford 2-4271) our Research Department.

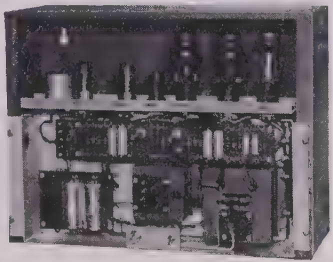
NEY GOLD

THE J. M. NEY COMPANY 171 ELM STREET • HARTFORD 1, CONN.

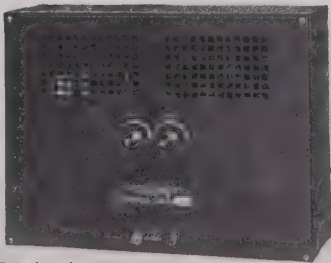
SPECIALISTS IN PRECIOUS METAL METALLURGY SINCE 1812

New! RMC aural AMPLIFIERS

TYPE 115 SERIES



Interior view. Note front servicability feature.



Exterior view

Sold through local Jobber

Write for Bulletin A1-51

Here is a three-stage, push-pull throughout Amplifier with high gain, low noise and distortion, the result of engineers' twenty years' experience, and long study of customers' needs before perfection. Designed for many uses in high quality sound systems, such as: (1) Reproducing systems for Vertical and Lateral disc reproduction. (2) Public address system working from Microphone to Speakers. (3) Used with bridging input attenuator as Monitor Amplifier for broadcast stations. (4) With bridging attenuator as Subscriber Amplifier for wired music installations. (5) For sound distribution systems in locations where available space is limited. Installation, service and maintenance operations all facilitated from front of Type 115 Amplifier. Can be permanently installed in wall cabinet; or for standard rack mounting.

TYPICAL ELECTRICAL CHARACTERISTICS

Gain 100 DB maximum with provision for reduction in gain to 64 DB.
Frequency Response plus and minus 1 DB over range 30 to 16,000 cycles.
Operates from 150 or 600 ohm source.
Operates into 4 ohm (2 to 8 ohm).
Operates into 16 ohm (8 to 32 ohm).
Operates into 150 ohm (75 to 300 ohm).
Operates into 600 ohm (300 to 1200 ohm).
Output power approximately 15 watts, 5% total harmonic distortion.
Output noise equivalent to an input signal of minus 120 DB below .006 W. at maximum gain unweighted (approx. minus 130 DB weighted). Frequency characteristic plus and minus 1 DB over the range 30 to 16000 cycles.

Export: Rocke International Corporation, 13 East 40th Street, New York 16, N.Y.

RADIO-MUSIC CORPORATION

PORT CHESTER • NEW YORK

MEASUREMENTS CORPORATION *MODEL 80*

STANDARD SIGNAL GENERATOR

2 to 400 MEGACYCLES

MODULATION: Amplitude modulation is continuously variable from 0 to 30%, indicated by a meter on the panel. An internal 400 or 1000 cycle audio oscillator is provided. Modulation may also be applied from an external source. Pulse modulation may be applied to the oscillator from an external source through a special connector. Pulses of 1 microsecond can be obtained at higher carrier frequencies.

FREQUENCY ACCURACY ±.5%

OUTPUT VOLTAGE 0.1 to 100,000 microvolts

OUTPUT IMPEDANCE 50 ohms

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

Your Most Complete Source of Supply for
RADIO and ELECTRONIC
EQUIPMENT • COMPONENTS • ACCESSORIES

TREMENDOUS STOCKS

is *Newark!*

TRAINED PERSONNEL

No matter what your need — whether Tubes, Components, Test Equipment, Receivers, Transmitters, or Public Address, you can save time and SAVE MONEY by shopping "Newark" first! As one of the largest distributors of radio and electronic components in America, we've got what you want — IN STOCK!

You'll like dealing with "Newark" because —

- Our tremendous stocks of standard brand merchandise always on hand insure speedy shipment of your order.
- Our highly specialized and competent personnel will know what you're talking about.
- Our Special Order Department performs miracles in getting those hard-to-find items that nobody else has!
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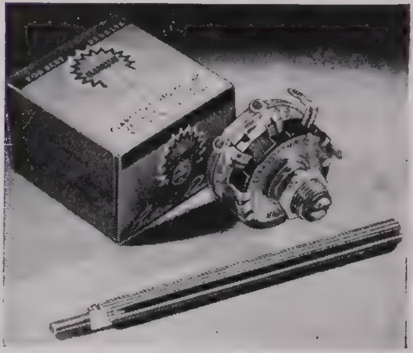
New York City Stores: 115-17 W. 45th St. & 212 Fulton St

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 61A)

Slip-Drive Volume Controls

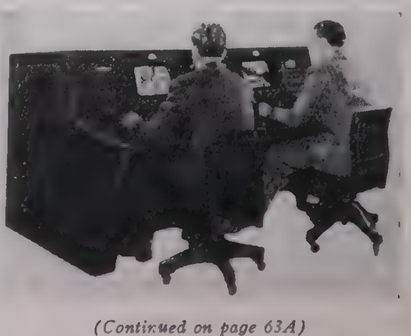


Slip-Drive (Clutch Type) volume controls to take attachable shafts are announced by **Clarostat Manufacturing Co., Inc.,** 130 Clinton St., Brooklyn, N. Y.

These controls, used mainly in auto sets and also in home radios with motor-driven operation, provide the essential slippage if the control shaft is turned beyond the end limits, thereby avoiding damage. This "SD" series is available in "Z" taper values from 250,000 ohms to 2 megohms, and in tapped units of the same total ohmage but tapped at 125,000, 250,000, and 500,000 ohms, working with a wide choice of Clarostat attachable shafts.

Dual Iconoscope Film Pickup System

Appreciative of the vital role which film must continue to play in the lengthening hours of television programming, the Television Equipment Division of **Allen B. DuMont Laboratories, Inc.,** 42 Harding Ave., Clifton, N. J., announces the DuMont Model TA-512-A Dual Iconoscope Film Pickup System with latest refinements and innovations.



(Continued on page 63A)

The manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

In the form of sectional units for the control console, cabinet racks, and pickup units, this equipment can keep step with telecasting requirements from the modest start to the most elavorate commercial operations, yet with minimized investment and obsolescence.

Housed in rectangular, upright metal cabinets, the film-pickup units are either floor-mounted or mounted on a track attached to the wall, allowing rapid-positioning before one projector or another.

Voice-Activated Magnetic-Tape Recorders

The development of a voice-activated instantaneous start-stop clutch mechanism, now available as optional equipment on any *Magnetape Recorder*, has been announced by the Magnephone Division of **Amplifier Corp. of America,** 398-1 Broadway, New York 13, N. Y.

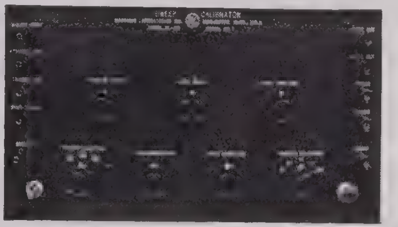
Activated by the voice of the speaker, singer, or other preselected sounds, the voice-clutch-equipped recorder continues to record as long as the sound is maintained, and for approximately five seconds thereafter to compensate for any pause. Actually, the time the recorder will operate after the sound has ceased depends upon the length of time the speech or music has been going on, and on its volume. Thus, the instrument's period of expectation increases with the increased possibility of additional sounds following.

The sensitivity of the voice clutch may be manually regulated by manipulation of the instrument's recording volume control to match the normal volume of any voice. This also serves to prevent activation of the Magnetape Recorder by extraneous room noises.

Further information may be obtained by writing to the manufacturer for Catalog 4901.

Model GL-22 Sweep Calibrator

The **Browning Laboratories, Inc.,** of Winchester, Mass., recently announced the Model GL-22 Sweep Calibrator as an addition to their line of electronic equipment.



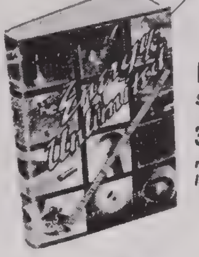
This is a pulsed timing-marker oscillator designed for use with standard oscilloscopes and synchroscopes for the measurement of time intervals on either triggered or recurrent sweeps. Variable-amplitude markers of either polarity are provided with sufficient amplitude for use as intensity markers or directly on the cathode-ray-tube plates as deflection markers. Markers available are 0.1, 0.5, 1.0, 10, and 100 μs. A positive or negative variable-width gate pulse output is provided for test purposes. The duration of this pulse corresponds to the duration of the marker group. All controls and output connections are brought to the front panel for operational convenience. The instrument weighs 20 pounds and its size is 14×7×7 inches.

Model 125-A Oscillator-Wavemeter

The **Brown Engineering Co.,** 4635-37 S.E. Hawthorne Blvd., Portland 15, Ore., are producing a small, light-weight, oscillator-wavemeter known as Model 125-A. This compact multipurpose instrument is convenient for use in the laboratory or field, and the carrying handle is located so there is complete accessibility of controls when in use. The frequency dial is provided with a vernier control for ease of adjustment and all controls are plainly marked as to their use. A panel meter is provided to indicate resonance when coupled to a circuit.

Model 125-A may be operated as an r.f. oscillator, modulated or unmodulated, with a frequency range of 400 kc. to 150 Mc. Coils are supplied to cover the standard broadcast intermediate frequency ranges. It may also be operated as an r.f. or a.f. signal tracer with visual and aural indication available simultaneously. Other applications are: heterodyne wavemeter; transmitter monitor; and a 400-cycle audio signal source. Write to the manufacturer for descriptive bulletin.

(Continued on page 64A)



JUST OUT!

ENERGY UNLIMITED

THE ELECTRON AND ATOM IN EVERYDAY LIFE

by

Harry M. Davis

Science Editor of Newsweek

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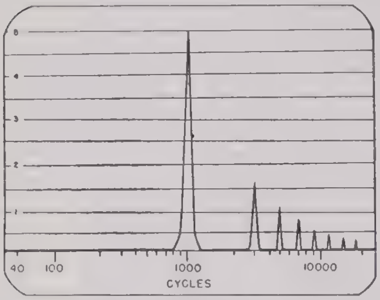

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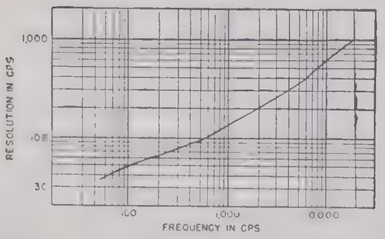

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 63A)

Klipsch Speaker System

A new two-way sound reproducer is being manufactured by **Brociner Electronics Laboratory,** 1546 Second Ave., New York 28, N. Y. A basically new design, the unique feature of the Klipsch Speaker System is its use of a horn for the low frequencies as well as for the high-frequency range. Conventional two-way speaker systems use a direct radiator for the low frequencies.

The Klipsch low-frequency horn is folded, and uses the corner of the room as an integral part of the acoustic system, so that, occupying only 14 cubic feet of space, it provides performance equivalent to conventionally designed horns 8 to 16 times as bulky. Such large horns could not practically be used in a living room, while the Klipsch Speaker System fits unobtrusively into a corner, where it utilizes the converging walls and floor as an extension of the low-frequency horn. The listener is literally inside the loudspeaker.

With both the high- and low-frequency speakers coupled to horns, their relative efficiencies are nearly equal. Thus, it is not necessary to attenuate the high-frequency unit markedly to match the low-frequency output, as in the case of direct radiators. The gain in efficiency permits the use of a relatively simple, high-quality triode amplifier of moderate cost, for most applications.

The nonresonant character of the speaker system affords reproduction of transients without hangover; there is no resonant frequency in the bass range to be excited by all notes in its vicinity. Bass instruments are clearly recognized. Fundamentals from 30 to 15,000 cycles are cleanly reproduced and uniformly distributed throughout the room.

The Klipsch Speaker System is available as a complete unit, and the individual components such as the high- and low-frequency horns, drivers, and dividing network, can be obtained separately. The Model 1A, illustrated, is rated at 20 watts. Other models provide power-handling capability up to 60 watts in one unit.

New Metal Signs

Engraved brass, aluminum, or stainless-steel signs with letters engraved to 0.02 inch depth and filled with any desired color of baked enamel, fitted in new slide-type wood or metal frames, are now being made by **The Acromark Co.,** 9-13 Morrell St., Elizabeth 4, N. J.

(Continued on page 66A)

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Designed to meet the demand for suitable light-weight elements for use in horizontal arrays and similar applications, Premax Tubular Elements are of a special construction that assures exceptional strength, light weight and rigidity, so essential in horizontal arrays. They are fully adjustable and possess the electrical conductivity you have been seeking.

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CORULITE ELEMENT KITS—Contain elements and mountings, together with working drawings for wood frame and support. Available for 3-element 10 Meter, 4-element 10 Meter, 3-element 20 Meter and 4-element 20 Meter.

ROTARY BEAM KIT—Includes frame and three pairs of seamless duraluminum tubular elements with necessary insulators and hardware including T-match accessories but without transmission line. Adjustable for 6, 10- and 11-meter bands.

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Nine-pin miniature twin triode. Converter and r-f amplifier.

CHARACTERISTICS AND TYPICAL OPERATION, 12AT7

(Center-tapped heater permits either a 12.6-v or 6.3-v supply)

	Series	*Parallel*
Heater voltage (a-c or d-c)	12.6 v	6.3 v
current	0.150 amp	0.300 amp

Direct interelectrode capacitances, approx value without external shield (grounded cathode operation):

Grid-to-plate (each section)	1.45 mmfd
Input (each section)	2.5 mmfd
Output (Section No. 1)	0.45 mmfd
Output (Section No. 2)	0.35 mmfd

As Class A amplifier, each triode section:

Plate voltage	180 v
Grid bias voltage	–1 v
Amplification factor	62
Transconductance	6,600 micromhos
Plate current	11 ma

6AU6

Miniature r-f amplifier pentode. Best intermediate-frequency tube from standpoint of design economy.

CHARACTERISTICS AND TYPICAL OPERATION, 6AU6

Heater voltage (a-c or d-c)	6.3 v
current	0.3 amp

Direct interelectrode capacitances (measured without external shield):

Grid-to-plate (max)	0.0035 mmfd
Input	5.5 mmfd
Output	5.0 mmfd

As Class A amplifier:

Plate voltage	250 v
Screen (Grid No. 2) voltage	125 v
Grid bias voltage	–1 v
Transconductance	4,450 micromhos
Plate current	7.6 ma
Screen current	3 ma

12AU7

Nine-pin miniature general-purpose twin triode. Serves in place of the 6SN7-GT (common in earlier television-set designs) in synchronizing circuits and as a multi-vibrator.

TYPICAL OPERATION, 12AU7

(Center-tapped heater permits either a 12.6-v or 6.3-v supply)

	Series	*Parallel*
Heater voltage	12.6 v	6.3 v
current	0.15 amp	0.3 amp

As Class A_1 amplifier, each triode section:

Plate voltage	250 v
Grid voltage	–8.5 v
Amplification factor	17
Plate resistance	7,700 ohms
Transconductance	2,200 micromhos
Plate current	10.5 ma

6BG6-G

Power-amplifier pentode. Driver tube for the horizontal sweep circuit.

TYPICAL OPERATION, 6BG6-G

Heater voltage (a-c or d-c)	6.3 v
current	0.9 amp

As deflection amplifier:

D-c supply voltage	400 v
Peak positive surge plate voltage (approx)	4,000 v
Peak negative surge grid voltage (approx)	–100 v
D-c Grid No. 2 current	6 ma
D-c Grid No. 1 current	25 microamperes
D-c plate current	70 ma

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RATINGS, 1B3-GT/8016

Heater voltage, a-c	1.25 v
current	0.2 amp

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Peak inverse plate voltage (max)	40,000 v
Peak plate current (max)	17 ma
D-c plate current (max)	2 ma
Freq. of supply voltage (max)	300 kc

● Experienced tube engineers will be glad to work closely with you in applying these and other Ken-Rad types to new circuits in the development stage. Write KEN-RAD, *Electronics Department, General Electric Company, Schenectady 5, New York.*

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What procedures must you use to make A-1 experimental equipment?

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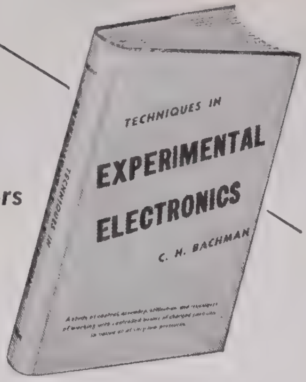

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EXPERIMENTAL ELECTRONICS

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Professor Bachman has assembled the results of his twelve years' experience in developing vacuum and electronic devices for industry in this excellent working manual. A unique feature is the inclusion of as many as possible of those techniques which the author learned "the hard way"—through personal effort.

He discusses equipment and techniques for the production and measurement of vacua, the preparation and design of glass tubulations, the production of glass seals, the preparation of cathodes and other electrodes, and the preparation and application of fluorescent materials. Many useful tables are included, as well as explanatory diagrams for such operations as severing glass tubing, preparing an end, beading a wire, hole patching, etc.

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 64A)

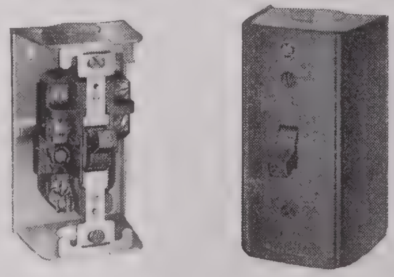
New 20-Ampere Variac Autotransformer

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., recently introduced the Type V-20 as the latest item in a new line of Variacs. It is capable of handling 20 amperes in the 115-volt model. Like the previously announced V-5 and V-10, the new V-20 delivers considerably more kva. per pound than older models. The 115-volt model, Type V-20M, is rated at 3.45 kva., and the 230-volt model, Type V-20HM, at 2.3 kva.

Output voltage is continuously adjustable from zero to 17% above input line voltage. Both models are supplied with case and terminal box cover. Terminal box is designed for use with BX or conduit.

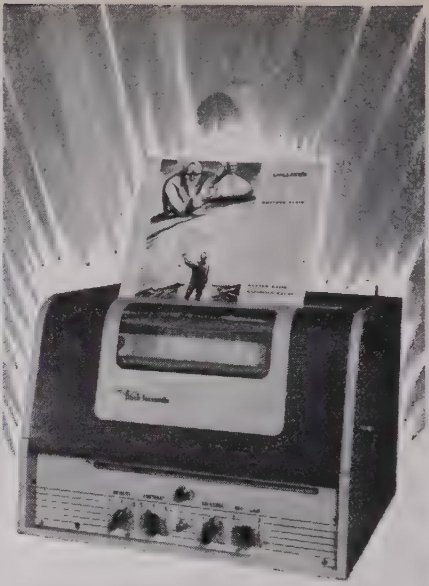
Exposed surfaces are made of corrosion-resistant materials with a durable black baked finish. Over-all dimensions are $7\frac{7}{8} \times 9\frac{5}{8} \times 5\frac{1}{2}$ inches, and the net weight is $22\frac{3}{4}$ pounds.

Starting Switch for Motors of 1 Horsepower or Less



Allen-Bradley Co., 114 W. Greenfield Ave., Milwaukee 4, Wis., announces the new *Bulletin 600* manually operated snap switch for starting motors of 1 horsepower or less. It is a streamlined unit with molded plastic cover, and has an overload device which operates on the soldered ratched principle. It is impossible to hold the switch closed under sustained overload, but it can be reset easily, with the regular switch lever, after the overload is cleared.

The switch unit can be furnished without enclosure for mounting in a standard switch box or machine base. Various types of enclosures are also available to meet any industrial requirement.



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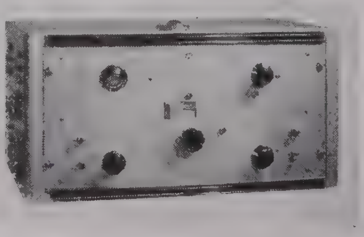
New R.F. Capacitometer

According to an announcement from the Specialty Division of **General Electric Co.**, at Electronics Park, Syracuse, N. Y., a new r.f. capacitometer, Type YCL-1, has been designed to measure capacitance from 0 to 10,000 μh. at a fixed radio frequency of 75 kc.



This new instrument is expected to have wide application in the component manufacturing, research and development laboratories fields.

News—New Products

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Suitable for portable use, the YCL-1 may also be removed from its cabinet and installed in a 19-inch relay rack. To provide stable operation despite line fluctuations, the internal measurement circuits are operated from a self-contained, electronically regulated power supply.

Calibration charts are used to convert dial readings for the measurement of capacitance in the range of 0 to 20,000 $\mu\mu$fd., and of inductance up to 10,000 μh.

The new r.f. capacitometer weighs 50 pounds, and is 11 inches high by 21 inches wide by 15 inches long.

New Crystal Microphone

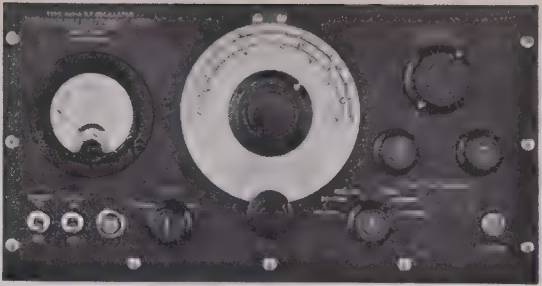
Described as the Velvet Voice Beauty, a new, convertible-type crystal microphone has recently been introduced by **The Astatic Corp.,** Conneaut, Ohio.

Made with a detachable quick-lock base, this microphone may be used as a hand or desk mike or mounted on a floor stand. It is made with bright chrome grille, gold-finish housing and handle, and dark brown baked-enamel base. There are two models: No. 200, with smooth, even frequency-response characteristics from 30 to 10,000 c.p.s.; and No. 241, with similar range but with rising characteristics between 1500 and 5500 c.p.s. for added brilliance in the speech range. Either model may be supplied with or without switch, as illustrated.

New Type S Time Switch

A new design in an unusually small, compact, low-priced time switch is being introduced to the trade by the **Sangamo Electric Co.,** Springfield, Ill. The over-all dimensions of the new switch are approximately 3 inches wide by 5⅜ inches high by 3 inches deep.

(Continued on page 68A)



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R-F
OSCILLATOR

for general laboratory use and as a signal source for R-F bridges

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- Output voltmeter
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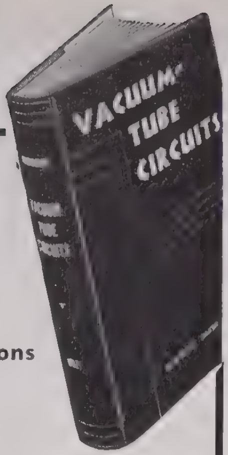

A basic
book for
communications
technicians

VACUUM TUBE CIRCUITS

By LAWRENCE B. ARGUIMBAU,
Assistant Professor, Department of
Electrical Engineering,
Massachusetts Institute of Technology

This book has been written in answer to the need for up-to-date literature on the subject of vacuum tube circuits. The selection of material contained in the book, and its presentation, have been carefully designed to cover the problems encountered in the field of communications.

The most recent information on the subject has been compressed and edited so that topics of major importance receive more detailed attention. The first chapter comprises an overall introduction with a comprehensive presentation of the interrelation of the various component parts to be discussed.

The treatment is developed carefully from simple circuits to those of a more complex nature. Emphasis is given to frequency modulation as opposed to amplitude modulation. In view of the rapid developments in the field of television, the book also includes much basic material on transient response and on the generation of micro-waves. Unusually full explanations throughout insure readability and understanding.

Contents: Radio Communication; Diodes and Rectifiers; Triodes, Pentodes, and Linear Amplifiers; Transient Response of Video Amplifiers; Amplitude Modulation and Tuned Amplifiers; Power Amplifiers; Oscillators; Inverse Feedback; Amplitude Modulation; Frequency Modulation; Pulses and Television; Micro-waves.

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 67A)

Designated as the Sangamo Type S Time Switch, it is powered by a newly developed high-torque, synchronous, self-starting low-speed motor that is lubricated for life. The switch is designed for easy mounting on a standard switch box, or for surface mounting on any wall.

Dynamic Noise Suppressor

A new and improved dynamic noise suppressor, Type 910-C, allows broadcast stations to transmit recorded music with a wide frequency range and greatly reduced background noise is now available from **Hermon Hosmer Scott, Inc.,** of Cambridge, Mass. It functions on the exclusive dynamic-band-pass principle, which is inherently distortion free. The new model features improved control circuits, extended frequency range, a continuous suppression control, and more flexible remote-control facilities.

(Continued on page 69A)

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News—New Products

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Projection Lens

Oscillograms may be projected on a large screen for lecture and demonstration purposes or for critical study of involved waveforms by means of a new lens offered as a cathode-ray oscillograph accessory by **Allen B. DuMont Labs., Inc.,** Clifton, N. J. The two-element symmetrical objective lens has a relative aperture of f/3.3 and focal length of 7.7 inches. It projects an oscillographic pattern of an area 3×3 inches from the tube screen to distances beyond 8 feet for a screen image up to 12 feet square. The lens is focused by means of a knob working in a diagonal slot.

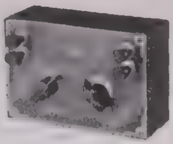
It is especially satisfactory with DuMont Types 247-A and 248-A cathode-ray oscillographs which use the high-voltage extra-brilliant Type 5RP-A cathode-ray tube. The lens flange has four mounting holes aligning with threaded holes in the front panel of the oscillograph.

Thermistors

Introduction of thermistors, electrical semiconductors that respond to temperature variations as small as 0.0001°C. is announced by the Metallurgy Division, Chemical Department, **General Electric Co.,** at Pittsfield, Mass. The devices are made from mixtures of semiconducting metallic-oxides and possess a high negative temperature coefficient.

Available in the forms of rods, disks, and beads, the thermistors are adaptable as the sensitive element in flow meters, time-delay relays, switching devices, and other types of indicators and controls. Since they are pure electrical resistances, they can be used with either a.c. or d.c. current. These thermistors may be actuated either by ambient temperatures or by internal heating of the element. Their negative coefficient of resistance may be used to offset the positive coefficient of resistance of conventional types of electrical conductors, so they can be used in instruments, meters, or other circuit components to correct errors caused by extreme temperature conditions.

FOUR NEW B&W INSTRUMENTS

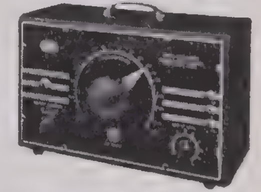


B & W SINE WAVE CLIPPER
Model 250

A device for generating a test signal particularly useful for examining the transient and frequency response of audio circuits.

B & W FREQUENCY METER
Model 300

An accurate and convenient means of making direct measurements of unknown audio frequencies up to 30,000 cycles. Integral power supply.



B & W AUDIO OSCILLATOR
Model 200

A source of stable, accurately calibrated frequencies between 30 and 30,000 cycles. Self-contained power supply.

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Model 400

Ideal for measuring low level audio voltages and determining their noise and harmonic content. Self-contained power supply.

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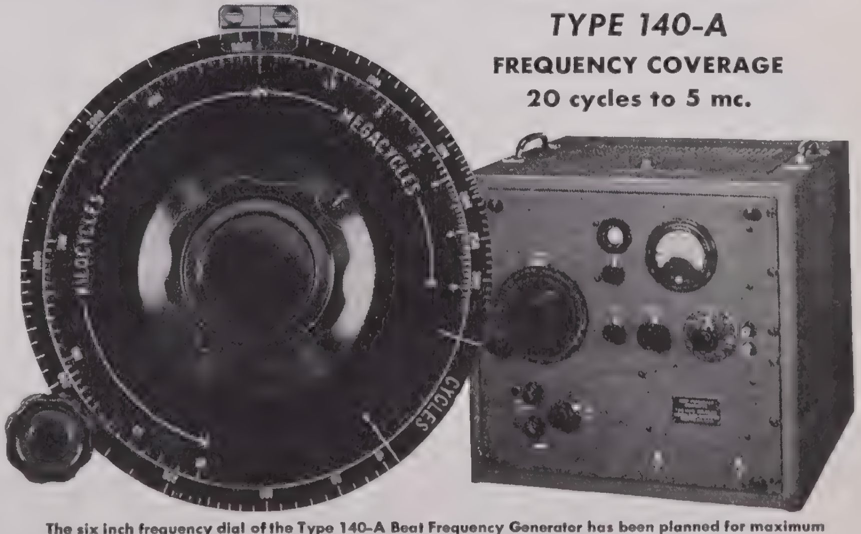
BEAT FREQUENCY GENERATOR

TYPE 140-A
FREQUENCY COVERAGE
20 cycles to 5 mc.



The six inch frequency dial of the Type 140-A Beat Frequency Generator has been planned for maximum readability and rapid setting, with combined scale lengths of the low and high ranges exceeding 22 inches. Continuous coverage of the entire audio spectrum is possible without bothersome range switching.

Frequency Range: 20 cycles to 5 megacycles in two ranges. ***Low Range:*** 20 to 30,000 cycles. ***High Range:*** 30 kc to 5 megacycles. ***Frequency Calibration:*** Accuracy ±2 cycles up to 100 cycles, ±2% above 100 cycles. ***Adjustment:*** High and low ranges have individual zero beat adjustments. Low range may be checked against power line frequency with front panel 1 inch cathode ray tube. ***Output Power and Impedances:*** Rated power output: one watt, available over the low frequency range from output impedances of 20, 50, 200, 500, 1000 ohms, and over both ranges from an output impedance of 1000 ohms. ***Output Attenuator:*** Five steps: X1.0, X0.1, X.01, X.001, X.0001. Distortion: 5% or less at 1 watt output; 2% or less for ½ voltage output. ***Write for Catalog "D"***

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NEWS and NEW PRODUCTS

May, 1948

Distortion and Noise Meter

A new distortion and noise analyzer for broadcast, television, research, and development applications has been announced by the Specialty Division, **General Electric Co.,** at Syracuse, New York. Combining four basic functions, the unit will measure percentage distortion down to 0.1%, measure the hum or noise present on an audio signal, act as a high-sensitivity vacuum-tube voltmeter, and perform as a frequency meter over the range of 50 to 15,000 c.p.s.

Distortion ranges of 1, 3, 10, 30, and 100% full scale are provided. The noise range is from +2 to −80 db. The noise frequency bandwidth is 30 to 30,000 c.p.s. on 600 ohms balanced input, and 30 to 75,000 c.p.s. on 100,000 ohms unbalanced input. When used as a vacuum-tube voltmeter, the same db range is used, corresponding to inputs between 1 volt and 80 microvolts, and bandwidths are the same as for noise measurements. Frequency can be measured between 50 and 15,000 c.p.s. in five ranges.

This analyzer, Type YDA-1, weighs approximately 45 pounds, and measures $21\times10\frac{1}{2}\times15$ inches. It may be mounted outside its case on any standard 19-inch rack.

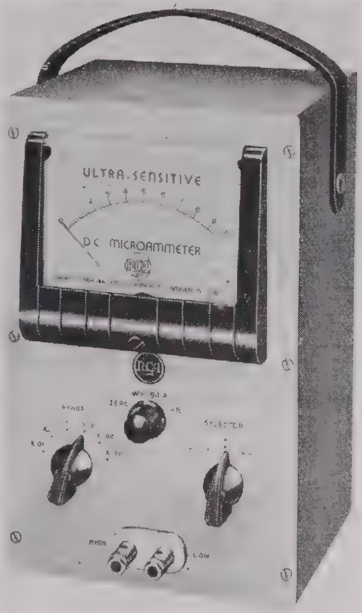
D.C. Timing Motors

A new series of low-current, high-impedance timing motors has been announced by **A. W. Haydon Co.,** Waterbury, Conn. The motors are matched to receiving tubes, and by operating over a period of time through the enclosed gearing, they will integrate the very small instantaneous energy input from the tubes and perform almost any desired amount of work. Connected in the plate circuit, the motors permit translation of a minute electrical function into a large amount of work without the use of thyratrons or other power equipment.

Each motor requires less than 270 milliwatts power input, drawing approximately 6 milliamperes at 45 volts d.c. It has a totally enclosed gear train, and speeds are 3200 r.p.m. down to 4 revolutions an hour. It is only $2\frac{1}{8}\times2\frac{1}{2}\times1\frac{3}{8}$ inches and weighs 6 ounces. By its use, designers of electronic equipment can simplify circuit layouts for automatic radio-frequency controls, self-seeking control devices, sensitive power relays, and photoelectric controls.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

D.C. Microammeter



A new ultrasensitive electronic microammeter, capable of accurately measuring d.c. currents down to one-billionth of an ampere, has been designed by the Tube Department, **Radio Corp. of America,** Harrison, N. J. It is a portable, battery-operated, vacuum-tube meter, whose usefulness extends to all fields. Current ranging from 0.001 to 1000 microamperes can be measured with the instrument, which has six range settings permitting a choice of the most convenient range. The current sensitivity approaches that of a reflecting galvanometer. An important feature is its capability of withstanding accidental overloads of 10,000% without damage to the meter movement.

By adding suitable external multiplier resistors, the microammeter can be converted to an extremely high-resistance voltmeter. On the lowest range, this gives the instrument an input resistance of 100 megohms per volt, providing an almost perfect method for measuring voltages with unusually low current drain. The microammeter can also be used as a high-range ohmmeter when connected to a suitable power supply. For example, when used with a 45-volt battery, the instrument will measure resistances as high as 4500 megohms, and can be used to measure leakage resistance of insulation.

Cathode-ray Oscilloscope

A new oscilloscope of exceptional performance for industrial and radio applications is available from **FURZEHILL LABORATORIES** of England.

Equipped with high-gain amplifiers for both axes, it has a separate sync amplifier, time-base circuit, and two electronically stabilized power supplies. A $3\frac{1}{2}$-inch fine-focus tube is used, and all normal operating controls and connections are on the front panel. The gun, modulator and deflector plates are available at terminals at the rear of the instrument. Particularly valuable features are the instantaneous shifts, controllable expansion of the time-base sweep independent of frequency, and negligible phase-shift over the entire range from zero to 3 Mc.

The first models have recently arrived in this country and information may be obtained from **AMERICAN BRITISH TECHNOLOGY INC.,** 57 Park Avenue, New York 16, N. Y.

Wire Shielding

Mild steel, spring steel, copper, or brass, with plain or tinned finish, provide the economy, springiness, or corrosion resistance inherent in the improved flat-wire *Monocoil* casing now in production by **Elliott Manufacturing Co.,** Binghamton, N. Y.

Uses are in installations where it is necessary to shield wiring electrically and mechanically to avoid interference with radio circuits. The casing has smooth inner and outer surfaces and can accommodate single or multiple wires. A special bulletin explaining features and application, together with samples, will be supplied by the manufacturer upon request.

NOTICE

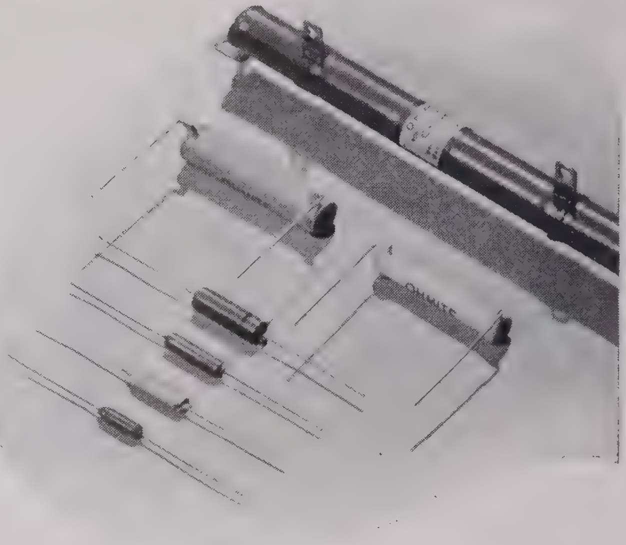
Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Industry Research Division, Proceedings of I.R.E., Room 707, 303 West 42nd St., New York 18, N.Y.** Photographs, and electrotypes if not over 2″ wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

(Continued on page 24A)

OHMITE plate chokes

"FREQUENCY-RATED"

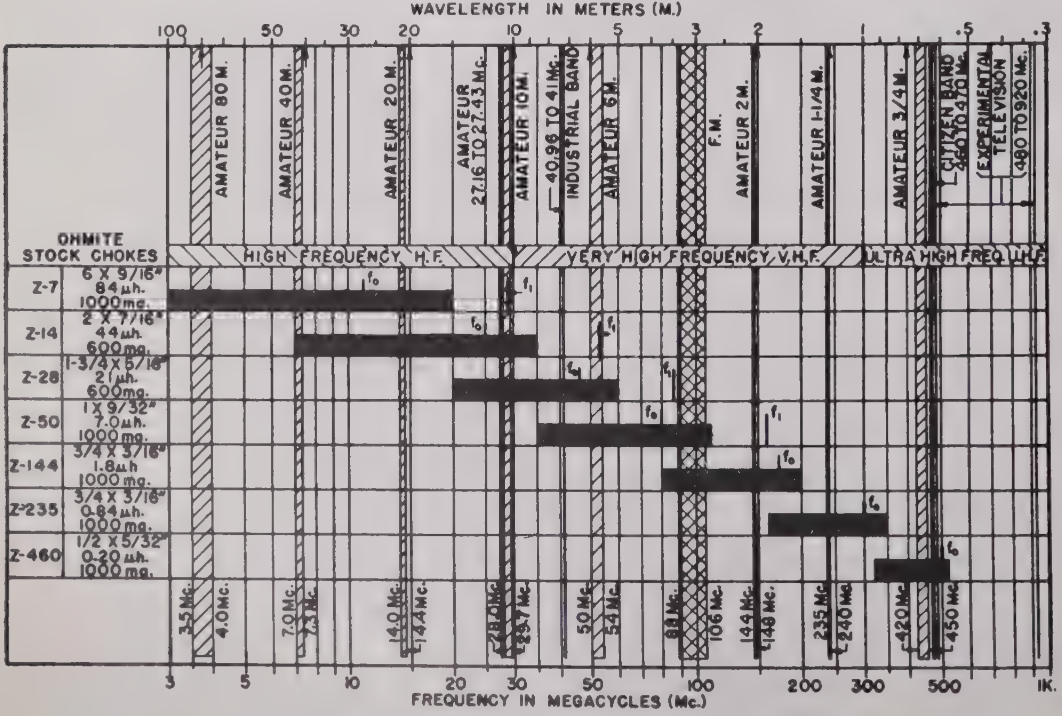
for easy selection and top performance



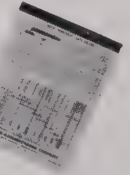
● Now, for the first time, you can select a plate choke for a particular frequency and know that it will give excellent performance at this frequency. The Ohmite line of plate chokes are "frequency-rated"—their frequency characteristics have been accurately predetermined. The chart below gives the operating frequency range for each of the seven sizes.

Ohmite single-layer wound, r.f. plate chokes cover the entire frequency range of 3 to 520 megacycles. These chokes are wound on low power factor plastic or steatite cores, and are insulated and protected by a moistureproof coating. All chokes are rated 1000 ma except the Z-14 and Z-28, which are rated at 600 ma. Further information will be supplied upon request.

RECOMMENDED OPERATING FREQUENCY RANGES OF OHMITE R. F. PLATE CHOKES



WRITE FOR PLATE CHOKE BULLETIN No. 133.



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-hp- SETS A NEW PERFORMANCE STANDARD!

YOU GET ALL THESE FEATURES IN THIS NEW HIGH FIDELITY SIGNAL GENERATOR

- **Voltage accurate within 0.2 db**
- **Distortion less than 0.1%**
- **Continuously variable a-f voltage**
- **Frequency range 20 cps to 20 kc**
- **High stability of frequency**

-hp- 206A Audio Signal Generator

For the first time *all* the features listed above are combined in one precision instrument, to give you signals of *utmost purity and accuracy* for high fidelity measuring work.

In addition, the new *-hp-* 206A Generator includes low-temperature coefficient frequency determining elements for high stability and unvarying accuracy over long periods of time. A precision attenuator varies output signal level in 0.1 decibel steps throughout 111 decibels.

Resistance-tuned Oscillator

The resistance-tuned oscillator is followed by an automatically tracked amplifier whose high selectivity reduces oscillator harmonics. Following the 111 db attenuator is a transformer which can be matched to loads of 50, 150 and 600 ohms. A 600 ohm single-ended output is also provided (Fig. 1).

Specially designed for testing high quality audio circuits, the *-hp-* 206A is ideal for FM transmitter maintenance, studio amplifier and console testing, a source for bridge measurements, a-f voltage or transmission measurements; and for other applications requiring a very low distortion signal of known amplitude.

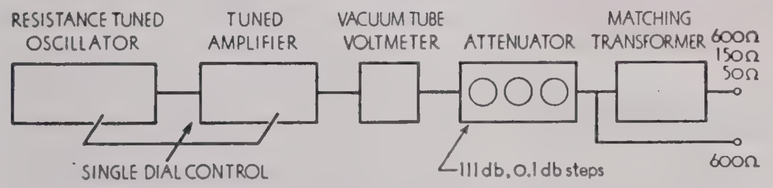

Figure 1 — Circuit Structure of -hp- 206A Generator

Full details available on request

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301 Clay Street • San Francisco, Calif., U. S. A.

SPECIFICATIONS

FREQUENCY RANGE: 20 cps to 20 kc, 3 bands.

CALIBRATION: Direct in cps on lowest band.

STABILITY: Better than 2%. Low temperature coefficient frequency network.

OUTPUT: +15 dbm into 50, 150, 600 ohms. Approx. 10 v into open circuit.

OUTPUT IMPEDANCE: 50, 150, 600 ohms balanced. 600 ohms single ended. Matched internal impedances.

FREQUENCY RESPONSE: Within 0.2 db, 30 cps to 15 kc, beyond meter, at all levels.

DISTORTION: Less than 0.1% above 50 cps. Less than 0.25% below 50 cps.

HUM LEVEL: 70 db below output signal, or 100 db below zero level.

OUTPUT METER: Reads in dbm or volts.

ATTENUATORS: 111 db in 0.1 db steps. Accuracy approximately 0.1 db.

-hp- laboratory instruments
FOR SPEED AND ACCURACY

Power Supplies *Frequency Standards* *Amplifiers* *Electronic Tachometers* *Frequency Meters*
UHF Signal Generators *Square Wave Generators* *Audio Frequency Oscillators* *Attenuators*
Audio Signal Generators *Noise and Distortion Analyzers* *Wave Analyzers* *Vacuum Tube Voltmeters*

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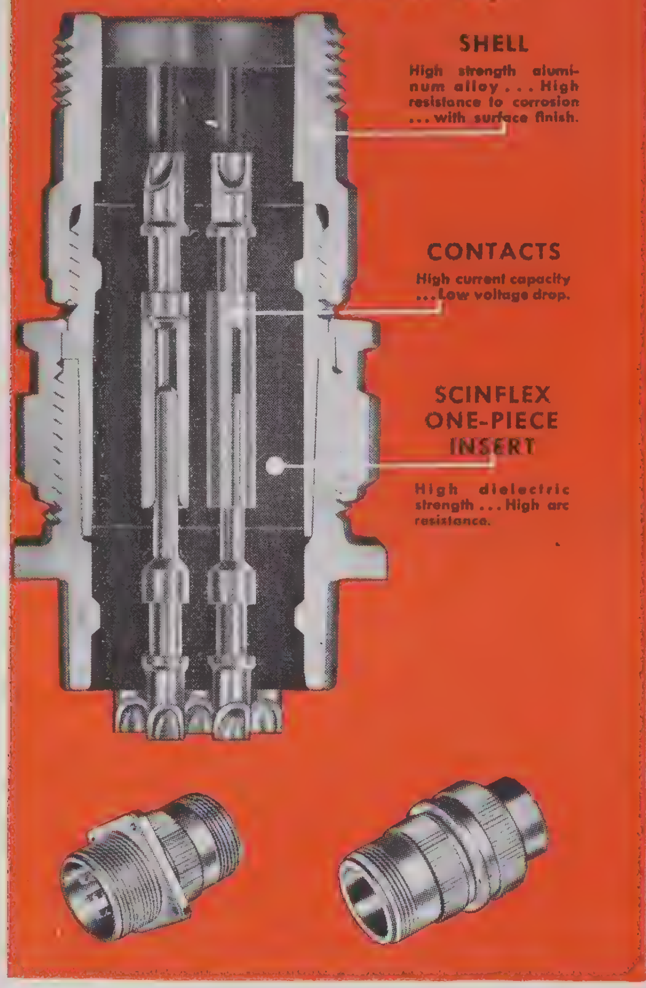
the finest ELECTRICAL CONNECTORS
money can build or buy!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CONTACTS
High current capacity . . . Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High arc resistance.

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Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—an exclusive feature that means lower maintenance cost and better performance.

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- Moisture-proof, Pressure-tight
- Radio Quiet
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Available in all Standard A.N. Contact Configurations

BENDIX SCINTILLA
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SIDNEY, N. Y.
DIVISION OF
Bendix
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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 11A)

Small High-Torque Motor

A 20-watt shaded-pole induction-type motor with high torque capacity is being marketed by the **T. C. Smith Manufacturing Co.,** Springfield, Ill. Small enough to fit in the hand, this motor has a stalling torque of 75 inch-ounces. It has a built-in gear train with oil-impregnated powdered metal bearings. The no-load speed is 20 r.p.m. on the output shaft. Other gear ratios can be supplied.

A particular feature of this motor is its magnetic clutch. With the deenergizing of the motor, this clutch prevents any over-travel of the output shaft. The motor is particularly suited for use with directional antennas and other control applications.

Radio Relay Link Equipment

New equipment for broadcasting stations to relay programs from studios to transmitter has been developed by the Transmitter Division of **General Electric Co.,** Electronics Park, Syracuse, N. Y. The equipment consists of a transmitter, receiver, and two antennas, which operate on frequencies between 920 and 960 mc. Characteristics measured from transmitter input to receiver output include the following: a noise level at least 65 db below 100% modulation; harmonic distortion less than 1% from 50 to 15,000 cycles; audio-frequency response plus or minus 1 db from 50 to 15,000 cycles; stability of 0.005% of carrier frequency; and operation on a standard power supply.

The transmitter weighs about 450 pounds, and has a power output of 10 watts. Its audio input level is 10 dbm plus or minus 2 db. It is designed to feed the antenna through a conventional coaxial line. The transmitter may be remotely controlled over a telephone line. The crystal-controlled receiver weighs 70 pounds and is comprised of three units. Its audio output level is plus 18 dbm. The two antennas used in the system are 40-inch parabolic types with enclosed dipoles. Each weighs about 40 pounds.

(Continued on page 58A)

SPRAGUE
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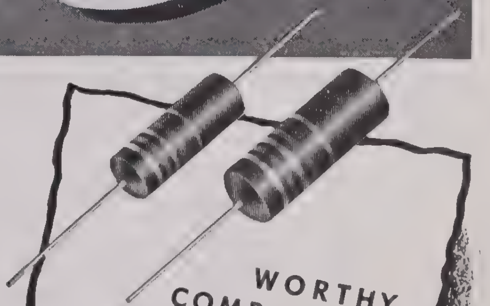
Announcing A NEW LINE OF SPRAGUE ELECTROLYTIC CAPACITORS

For operation up to 450 volts at 85° C.

With some 7 times as many components in a television receiver as in the average radio, the possibility of service calls is greatly increased. The new SPRAGUE ELECTROLYTIC line offers the first practical solution to this problem.

Designed for dependable operation up to 450 volts at 85° C. these new units are ideally suited for television's severest electrolytic assignments. Every care has been taken to make these new capacitors the finest electrolytics available today. Stable operation is assured even after extended shelf life, because of a new processing technique developed by Sprague research and development engineers, and involving new and substantially increased manufacturing facilities. More than ever before your judgment is confirmed when you *SPECIFY SPRAGUE ELECTROLYTICS FOR TELEVISION AND ALL OTHER EXACTING ELECTROLYTIC APPLICATIONS!* Sprague Electric Company invites your inquiry concerning these new units.



WORTHY COMPANIONS FOR THE NEW ELECTROLYTICS! SPRAGUE MOLDED TUBULARS . . .

Highly heat- and moisture-resistant
Non-inflammable • Moderately priced
Conservatively rated for −40°C to +85°C operation
Small in size • Completely insulated
Mechanically rugged
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TUBES FOR
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DEFLECTION YOKES

These spirally laminated paper base, Phenolic Tubes are obtainable in sizes and with punching and notching that meet each customer's individual needs.

Quality performance at prices that appeal.

OTHER COSMALITE TYPES INCLUDE . . .

#96 Cosmalite for coil forms in all standard broadcast receiving sets.

SLF Cosmalite for Permeability Tuners.

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Motorola	Belmont
Zenith	Admiral
Farnsworth	Sentinel
Magnavox	Wells Gardner
Bendix Radio	Warwick

Inquiries given specialized attention

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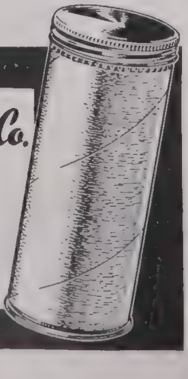

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SALES OFFICES: Room 5632, Grand Central Term. Bldg., New York 17, N.Y., also 647 Main St., Hartford, Conn.
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario

SECTION MEETINGS

ATLANTA

"The A.C. Network Calculator," by H. P. Peters, Georgia School of Technology; February 27, 1948.

BALTIMORE

"Some Types of Television Interference," by E. W. Chapin and F. D. Craig, Federal Communications Commission; January 27, 1948.

"General Mobile Telephone System," by C. L. Garrett and S. C. Miller, Chesapeake and Potomac Telephone Company; February 24, 1948.

BEAUMONT-PORT ARTHUR

"Frequency Control Methods for F.M. Transmitters," by A. D. Massey, Westinghouse Electric Corporation; January 13, 1948.

"Nucleonics and its Applications," by J. H. Stewart, Industrial Radiography Laboratories; February 18, 1948.

BOSTON

"The Possibilities for Transatlantic F.M.," by L. B. Arguimbau, Massachusetts Institute of Technology; February 26, 1948.

CHICAGO

"Television from Transmitter to Receiver," by H. F. Hafker, D. R. Yoder, H. E. Lawrence, and R. Hansen, Radio Corporation of America; February 20, 1948.

CLEVELAND

"New Developments in Subminiature Tubes," by W. R. Jones, Sylvania Electric Products Inc.; February 19, 1948.

CONNECTICUT VALLEY

"Television," by R. F. Foster, General Electric Company; February 26, 1948.

DAYTON

"The Baldwin Electronic Organ," by J. F. Jordan and P. Mooter, Baldwin Company; February 26, 1948.

DETROIT

"Operating Problems in Television Broadcasting," by L. Spragg, Radio Station WWJ; January 16, 1948.

"Power Line Carrier," by H. W. Lensner, Westinghouse Electric Corporation; February 20, 1948.

LOS ANGELES

"A New Magnetic Tape Recorder With Performance Characteristics To Match F.M. Broadcast Requirements," by H. Lindsay and M. J. Stolaroff, Ampex Electric Corporation; February 17, 1948.

"The Present Status Of High Quality Wire Recording," by R. G. Leitner, Lear, Inc.; February 17, 1948.

"Teleran—Air Navigation and Traffic Control by Means of Television and Radar," by R. W. K. Smith, Radio Corporation of America; February 17, 1948.

LOUISVILLE

"Dielectric Heating," by P. L. Wilson, The Girdler Corporation; February 20, 1948.

MONTREAL

"Reproduction of Sound," by H. F. Olson, RCA Laboratories Division; February 25, 1948.

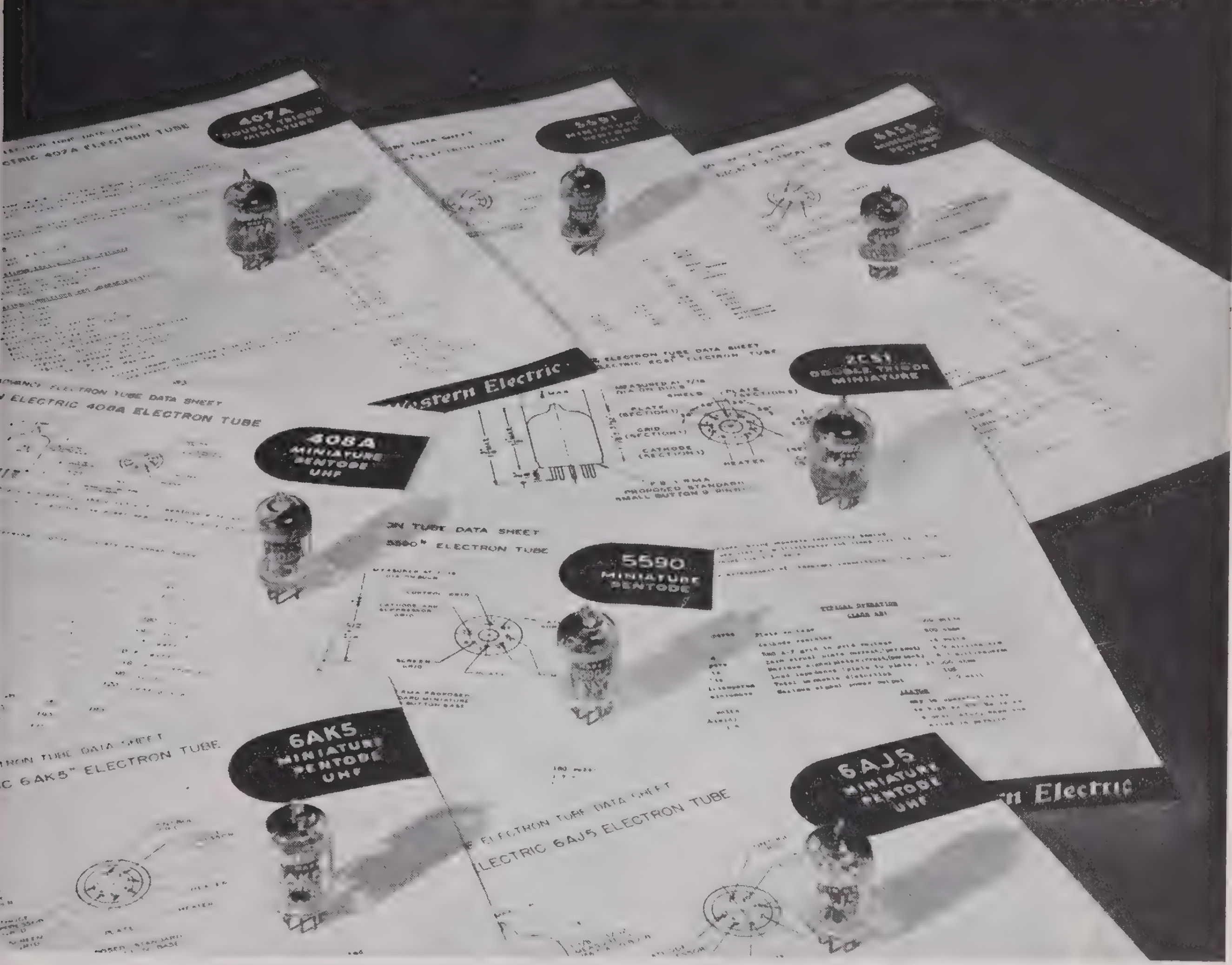
"Planning, Building, and Operating Canada's International Shortwave Boradcasting Service," by G. W. Olive, J. E. Hayes, D. G. McKinstry, W. A. Nichols, and R. D. Cahoon, Canadian Broadcasting Corporation; March 11, 1948.

NEW YORK

All-Day Symposium on "The Design and Use of Television Receivers," Morning Session Moderator: Arthur Loughren, Hazeltine Electronics Corp-

(Continued on Page 36A)

Get the facts on Western's miniatures!


407A
DOUBLE TRIODE
MINIATURE
2C51
DOUBLE TRIODE
MINIATURE
Western Electric
408A
MINIATURE
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UHF
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Western Electric is now offering a group of miniature tubes, including 2 twin triodes and 6 pentodes. They were developed by Bell Telephone Laboratories...are manufactured by Western Electric to the high standards of quality for which all Western Electric tubes are noted. Data sheets on all these miniatures are available for your design files. Send the coupon for sheets on the types you are interested in—or call your Graybar Representative for full information.

CODE	TYPE	HEATER VOLTAGE	HEATER CURRENT IN MILLIAMPERES	MAX. PLATE VOLTAGE
6AS6	Pentode	6.3	175	180
6AK5	Pentode	6.3	175	180
6AJ5	Pentode	6.3	175	180
5590	Pentode	6.3	150	180
5591	Pentode	6.3	150	180
408A	Pentode	20	50	180
2C51	Twin Triode	6.3	300	300
407A	Twin Triode	20 (parallel)	100 (parallel)	300
		40 (series)	50 (series)	300

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R H
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. . . a stable crystal unit in a miniature holder manufactured to tolerance of 0.005% over an extreme range of −55° C to +90° C. The new RH-7B crystal exhibits 50% to 80% less frequency shift with a given change in oscillator input capacity. Hermetically sealed, the RH-7B produces high activity (series resistance less than 400 ohms) and meets Army and Navy specifications.

For detailed specifications write for bulletin RHC-X.

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CHERRY AND NORTH STREETS • CARLISLE, PA.

SECTION MEETINGS

(Continued from page 34A)

oration; Afternoon Session Moderator: Murray Crosby, Paul Godley Company; February 28, 1948.

"Television Receiving Antennas," by A. Alford, Consultant.

"Television Antenna and R.F. Distribution Systems for Apartment Houses," by H. E. Kallmann, Consultant.

"Automatic Frequency Control of Television Sweep Circuits," by E. L. Clark, RCA Victor Division.

"Standards for Testing Television Receivers," by D. G. Fink, McGraw-Hill Publishing Company.

"Intermediate Frequencies for Television Receivers," by P. F. G. Holst, Crosley Division, AVCO Manufacturing Company.

"Design Considerations in Intercarrier Sound Television Receivers," by S. W. Seeley, RCA Laboratories Division.

"Television Tuners," by A. Valdettaro, Sarkes Tarzian.

"Standardization of Transient Response of Television Transmitters and Receivers," by R. D. Kell and G. L. Fredendall, RCA Laboratories Division.

"A Thermionic Device with A Sense of Smell," by W. C. White, General Electric Company; March 3, 1948.

OTTAWA

"The Moter Vessel 'Radel' " by H. Ross Smyth National Research Council; February 12, 1948.

PHILADELPHIA

"Modern High Energy Accelerators," by R. V. Langmuir, General Electric Company; March 4, 1948.

PITTSBURGH

"Marine Radar," by C. London, Westinghouse Electric Corporation; March 8, 1948.

SACRAMENTO

"Design Factors Influencing Radio Spectrum Conservation," by D. E. Noble, Motorola Inc.; January 29, 1948.

"Watts in Glass," by H. B. Little, Owens-Corning Fiberglass Corporation; February 17, 1948.

ST. LOUIS

"Studio Acoustics," by K. C. Morrical, Washington University; February 26, 1948.

SAN DIEGO

"Problems of Architectural Acoustics in Broadcast Studios," by C. R. Moe, San Diego State College; March 2, 1948.

SEATTLE

"Use and Adjustment of Feedback in A.M. Transmitters," by J. C. Herber, Western Electric Company; February 20, 1948.

WASHINGTON

"Ultrasonic Echo-Ranging Applied to Guidance Devices for the Blind," by F. H. Slaymaker, Stromberg-Carlson Company; March 8, 1948.

SUB-SECTIONS

FORT WAYNE

"Cathode-Follower Television Antenna," by G. C. Hills, Belmont Radio Corporation; February 9, 1948.

LANCASTER

"Particle Accelerators in Science and in Industry," by W. P. Simpson, General Electric Company; March 10, 1948.

TOLEDO

"Coaxial Lines," by J. S. Brown, Andrew Corporation; January 26, 1948.

"Electronic Voltmeters and Signal Generators for F.M., A.M., and Television," by C. J. Sheridan, The Triplett Electrical Instrument Company; February 23, 1948.

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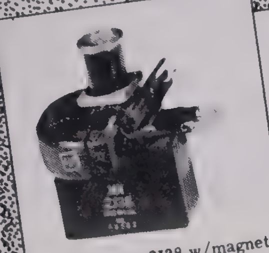
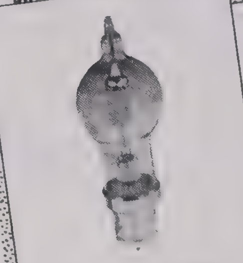
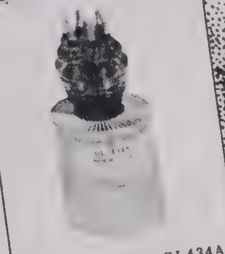
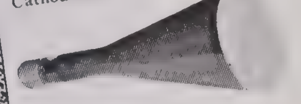
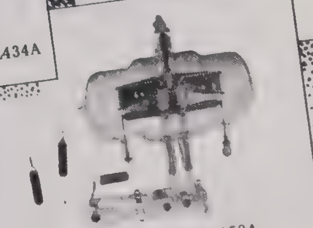

Magnetron - 2J38 w/magnet

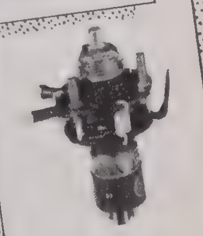
Magnetron - 5J29

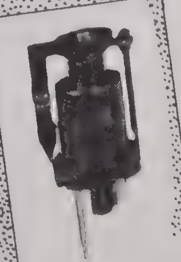

Rectifier - 250R


Transmitting - GL434A


Cathode Ray - 5AP1


Transmitting - VT-158A


Klystron - 417A


Klystron - 723A/B

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2J48	15.95
4J26	15.95
5J23	15.95
5J29	15.95
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5JP2	3.95
12GP7	12.50

Klystrons

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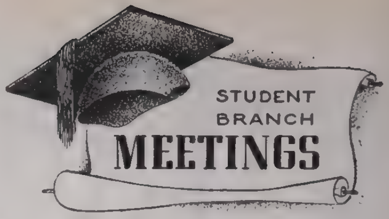


STUDENT BRANCH MEETINGS

University of Alberta, I.R.E.-A.I.E.E. Branch

"Radar and Radio Navigation Aids," by G. Robson and G. Allred, Students; February 25, 1948.

University of Arkansas, I.R.E. Branch

"Radar on the Destroyer," by R. H. Barton, Student; February 18, 1948.

University of California, I.R.E.-A.I.E.E. Branch

"Design and Performance of High-Voltage, High-Capacitance Oil Circuit Breaker," by A. E. Brock, Pacific Electric Manufacturing Company; March 4, 1948.

University of Illinois, I.R.E.-A.I.E.E. Branch

"The Electrical Age," by M. L. Enger, University of Illinois; February 26, 1948.

"Pulse Code Modulation," by L. A. Meacham, Bell Telephone Laboratories; March 8, 1948.

Michigan State College,
I.R.E.-A.I.E.E. Branch

"Microwave Demonstration," by W. Dernberger, Michigan Bell Telephone Company; February 5, 1948.

University of Michigan, I.R.E.-A.I.E.E. Branch

"Multistation Radio Relay Systems," by G. N. Thayer, Bell Telephone Laboratories; February 17, 1948.

Debate with Sigma Rho Tau on Resolved: Engineers Should Unionize; February 25, 1948.

The College of the City of
New York, I.R.E. Branch

"The Engineer and His Professional Society," by B. E. Shackelford, President, The Institute of Radio Engineers; February 24, 1948.

Northwestern University,
I.R.E.-A.I.E.E. Branch

"The Go of The Brain," by W. S. McCulloch, Illinois Neuropsychiatric Institute; February 13, 1948.

Stanford University, I.R.E.-A.I.E.E. Branch

"Some Factors in Television Studio Design," by F. R. Brace, Engineering Consultant; February 18, 1948.

University of Texas, I.R.E.-A.I.E.E. Branch

"Power Line Carrier for Rural Subscribers," by M. F. Noster, Southwestern Bell Telephone Company; March 1, 1948.

University of Washington,
I.R.E.-A.I.E.E. Branch

"Measurements," by N. Eldred, Hewlett Packard Corporation; February 6, 1948.

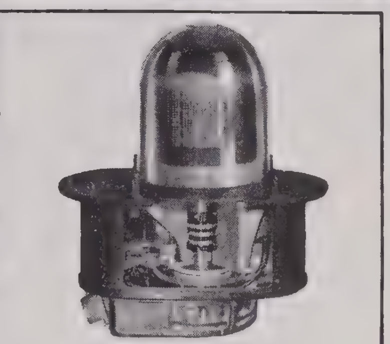
Wayne University, I.R.E.-A.I.E.E. Branch

"Radar and Microwaves," by W. H. Dernberger, Michigan Bell Telephone; February 27, 1948.

Worcester Polytechnic Institute,
I.R.E.-A.I.E.E. Branch

"A Critique of the Methods and Courses of Instruction at the Electrical Engineering Department at Worcester Polytechnic Institute," by L. Leavitt, Worcester County Electric Company, and several staff and student members of Worcester Polytechnic Institute; February 19, 1948.

The new, smaller Bendix Iron Core Loop shown here, superimposed in proper proportion on the outline of the air core type that it replaces, is visual evidence of reduction in size accomplished by the use of Stackpole Iron Cores. Air drag is reduced 72% because of this more efficient loop.



"Cut-away" view of new Bendix Automatic Loop Antenna. Note iron core in upper cutaway portion of hermetically sealed unit.

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Unusual as it may seem, careful research and modern electronic design has shown that the use of Stackpole Powdered Iron Cores increases the pay load of regular commercial aircraft.

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Stackpole Powdered Iron Cores are performing miracles like this for many other manufacturers, too. Improved performance, reduced costs, smaller physical sizes—these are some of the advantages that usually result when Stackpole Iron Cores are designed into inductive circuits. *Write on your company letterhead today for full information.* Ask for STACKPOLE Bulletin No. RC7B.

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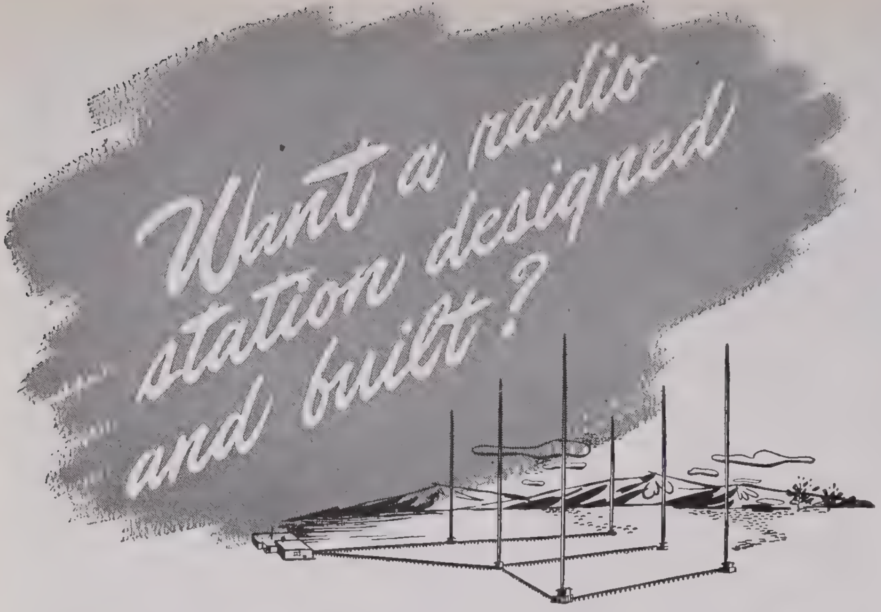
IRON CORE HEADQUARTERS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The Monona Broadcasting Company, Madison, Wisconsin, had the money but no station. Faced with "impossible" allocation difficulties, they called on Andrew engineers, who succeeded in finding a frequency and designing a directional antenna system. Thus, WKOW was born. Within ten months after the construction permit was granted, Andrew engineers completely designed, built, tuned, and proved performance of a six-tower 10 kw. station – an unusually difficult engineering feat accomplished in record-smashing time. A complete "package" of Andrew transmission line and antenna equipment was used, again emphasizing Andrew's unique qualifications: Complete engineering service with unsurpassed equipment.

Mr. Harry Packard, General Manager of WKOW, wrote:

"Speaking for the entire staff of WKOW, I would like to congratulate the Andrew Corporation on the remarkable engineering job it performed in helping us get WKOW on the air.

We feel that the technical perfection of our installation is due in great part to the efficiency of Andrew equipment and engineering service.

In particular we wish to thank Mr. Walt Kean of the Andrew Broadcast Consulting Division who was responsible for conceiving and designing the installation, supervising construction of all antenna equipment, and doing the final tuning and coverage surveys."

A total of 13,618 feet of Andrew transmission line and complete phasing, antenna tuning, phase sampling and tower lighting equipment went into this job, complementing the best in engineering with the ultimate in radio station equipment.

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MEMBERSHIP

The following transfers and admissions were approved on April 6, 1948, to be effective May 1, 1948:

Transfer to Senior Member

Brustman, J. A., 180 Lalley Blvd., Fairfield, Conn.
Chu, L. J., 31 Winthrop Rd., Brookline, Mass.
Clark, R. L., 1502 N. Utah St., Arlington, Va.
Curtis, R. C., 25 Stanley St., New Haven 11, Conn.
Dolberg, C. E., 447 Tennis Ave., North Hills, Pa.
Dyke, E., 317 Hyde Park Ave., Bellwood, Ill.
Harkins, P. B., 166 Summit Rd., Elizabeth, N. J.
Harvey, N. L., 17 W. Rogues Path, Huntington Station, L. I., N. Y.
Hessel, J., 73 Woodland Dr., Fair Haven, N. J.
Joyner, A. A., 403 Center St., Haddonfield, N. J.
Lamb, J. J., Remington Rand, Inc., Wilson Ave., S. Norwalk, Conn.

Admission to Senior Member

Blanchard, A., 3001 University Blvd., Houston Tex.
Burlingame, B. O., 311 E. 72 St., New York 21, N.Y.
David, P. B., 140 Avenue de Suffren, Paris, France
El-Said, M. A. H., c/o Egyptian Education Bureau, 2200 Kalorama Rd., Washington 8, D. C.
Gill, H. A., 6 Eleventh St., Carle Place, N. Y.
Hafstad, L. R., 1611 Park Rd., Washington, D. C.
Houtsmuller, J., 32, Avenue Albert Lancaster, Brussels, Belgium
Loo, T. C., Chinese Government Radio Administration, Sassoon House, Shanghai, China
Monk, N., 463 West St., New York 14, N. Y.
Ooiman, A., 3762 Casilla, Buenos Aires, Argentina
Tashjian, D. R., 1245 Leeds Terr., Baltimore, Md.
Toth, E., 338 Baltimore Ave., Takoma Park 12, Md.
Vallese, L., Department of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa.
Zimmermann, H. J., 18A Thomas Rd., Swampscott, Mass.

Transfer to Member

Abramis, B. D., 4328 Illinois St., San Diego 4, Calif.
Beck, H. M., 3806 S. Capitol St., Washington, D. C.
Bierach, K. F., Jr., Zenith Radio Corp., 6001 Dickens Ave., Chicago 39, Ill.
Burns, L. L., Jr., RCA Laboratories, Princeton, N. J.
Cherry, L. B., Department of Physics and Engineering, Lamar College, Beaumont, Tex.
Corl, J. L., Sylvania Electric Products, Inc., 40-22 Lawrence St., Flushing, L. I., N. Y.
Cortright, R. D., 412 E. Melbourne St., Silver Spring, Md.
Croy, J. R., 4830 S. 28 St., Arlington, Va.
Davenport, W. B., Jr., 54 Westgate, Cambridge 39, Mass.
Dearborn, F. K., Jr., 75 Outlook Dr., Lexington, Mass.
Elbourn, R. D., 5332 Nevada Ave., N.W., Washington, D. C.
Fouty, R. A., 2031 Fairmont Ave., Columbus 4, Ohio
Gissler, F. E., 224 Green St., Boonton, N. J.
Grumich, J., 48-25—54 Rd., Maspeth, L. I., N. Y.
Harris, H. W., 711 Kentucky, Amarillo, Tex.
Hastings, C. L., 1604 West End Place, Greensboro, N. C.
Hodge, J., 1364 Ridgeley Dr., Los Angeles 35, Calif.
Hogg, C. B., Lamparilla No. 208, Havana, Cuba
Hopkins, J. E., 510 North St., East Aurora, N. Y.
Iffland, J. J., 711 Oakland Ave., Ann Arbor, Mich.
Kahnke, J., 1683 Marshall Ave., St. Paul 4, Minn.
Kreuzer, B., RCA Victor Division, Bldg. 15-5, Camden, N. J.
Learned, A. J., 2216 South Ave., Syracuse 7, N. Y.
Lovan, J. E., 411 Miller, Liberty, Mo.
Lowers, C. E., Curtiss-Wright Corp., Columbus 16, Ohio

MEMBERSHIP

McElroy, G. E., 100 Hudson Ave., Englewood, N. J.
Minneman, M. J., 2825 Hilldale Ave., Baltimore 15, Md.
Mooney, R. E., Box 298, Clinton, Ont., Canada
Ordung, P. F., Dunham Laboratory, Yale University, New Haven, Conn.
Pickarski, S., 1357 Wilhelmina Rise, Honolulu, T. H.
Roush, G. E., c/o Philips Laboratories, Inc., Irvington-on-Hudson, N. Y.
Rubin, M. D., Lab. 19, "G" Bldg., Raytheon Manufacturing Co., Seyon St., Waltham, Mass.
Shaw, R. H., 66 Old South Head Rd., Vaucluse, Sydney, N.S.W., Australia
Smith, F. W., Jr., 160-09 Grand Central Pkwy., Jamaica 2, L. I., N. Y.
Stello, K. H., 12026 Peoria St., Roscoe, Calif.
Thurston, W. R., Jr., 275 Massachusetts Ave., Cambridge 39, Mass.
Weyrauch, H. E., 1926 Fourth St., Bremerton, Wash.
Yelsey, B., 45 W. 75 St., New York 23, N. Y.
Yonker, F. H., 1205 E. Pine St., Phillipsburg, Pa.

Admission to Member

Bonapace, H., Brazilian Aeronautical Commission, 1501–18 St., N.W., Washington 6, D. C.
Breuer, H. J., 1150 Robertson Way, Sacramento 14, Calif.
Bricourt, P. A., 2019 Dickson, Sillery, Que., Canada
Chmilowski, J. B., 11013 S. Prairie Ave., Lennox, Calif.
Coates, F. M., 4112 Locust, Kansas City 4, Mo.
Constant, P. C., Jr., 405 E. 61 St., Kansas City 4, Mo.
Estevez, C. L., Carrera 7a, No. 19-70, Aptdo. Nacional 2605, Bogota, Colombia
Hackley, C. L., 1081 Keyes Ave., Schenectady 8 N. Y.
Hall, John R., 446 Pleasant St., South Weymouth, Mass.
Harris, J. B., 1924 N. 30 St., Kansas City 2, Kan.
Holland, C. R., 947 James St., Syracuse 3, N. Y.
Johnk, C. T. A., Electrical Engineering Department, Missouri School of Mines, Rolla, Mo.
Klekotka, J. A., Villanova College, Villanova, Pa.
Larson, R. C., 117 Chicago Blvd., Sea Girt, N. J.
Lemeshka, M. B., RCA Victor Division, New Holland Ave., Lancaster, Pa.
Marven, E. L., Box 4, Spickert Knob Rd., Floyd Knobs, Ind.
Milby, B. C., 615 Church St., Asbury Park, N. J.
Moltrup, G. R., 247 S. Barnard St., State College, Pa.
Opperman, A. G., 576 Douglas St., Akron 7, Ohio
Pearson, J. B., 4114 Lamar, Houston 3, Tex.
Preston, F. S., c/o Norden Laboratories, Inc., 121 Westmoreland Ave., White Plains, N. Y.
Priedigkeit, J. H., 825—53 St., Oakland 8, Calif.
Quanrud, O. G., Headquarters First Air Force, Fort Slocum, N. Y.
Ruston, J., 244A Summer Ave., Newark 4, N. J.
Schwenker, R. B., 130-21—220 St., Springfield Gardens, L. I., N. Y.
Sheitelman, H. D., 2902 Arundel Rd., Mt. Rainier, Md.
Tai, C., 16, Gordon Square, London, W.C.1, England
Watson, K. J., Box 383, California State Polytechnic College, San Luis Obispo, Calif.
Whitney, L. E., 319 Westmoreland Ave., Syracuse 10, N. Y.
Winlund, E. S., 12606 Everglade, Venice, Calif.
Witten, E. L., 4834 W. 139 St., Hawthorne, Calif.
Wrede, D. F., 26, St. Pauls Rd., Tottenham, London, N. 17, England

(Continued on page 42A)

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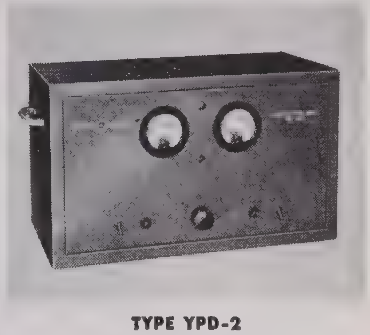
IMPEDANCE: Approximately 2 ohms at 30 cycles sec. Decreases with increasing frequency.
RIPPLE: Less than (.005) volts, peak to peak.
LOAD REGULATION: Less than 1 percent change in output voltage from no load to full load.


TYPE YPD-2
Range 250—450 Volts

POWER REQUIREMENTS: 105-125 volts, 60-cycle commercial power. Power input, approximately 375 watts.
OUTPUT POWER: 250-400 volts d-c, 200 milliamperes individually from two separate supplies, or 250-400 volts d-c, 400 milliamperes from both supplies when operated in parallel.
RIPPLE AND NOISE: Less than 0.020 volt rms.
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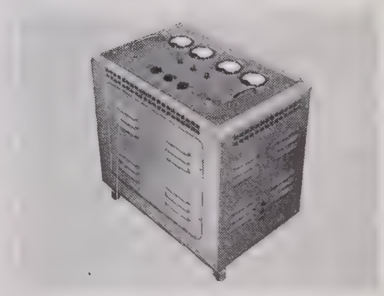
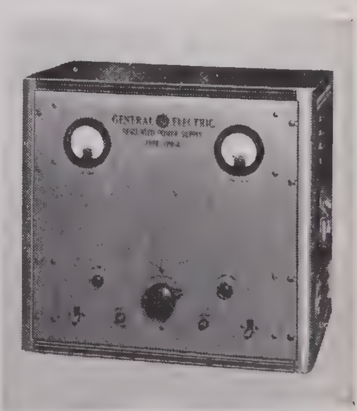

TYPE PS-4 (Dual Regulated)
Range 250—400 Volts

POWER REQUIREMENTS: 105-125 volts, 60 cycle commercial power. Power consumption approximately 800 watts at full load.
D-C OUTPUT: 0.125 ampere from 160 to 1500 volts output.
RIPPLE: Maximum 0.05 volt (peak to peak value).
LOAD REGULATION: 0.15 percent or less change in output voltage from no load to full load at any power line voltage and output voltage within rating.
LINE REGULATION: Less than 0.015 percent output voltage change per volt change in line voltage over specified range.
IMPEDANCE: Less than 10 ohms at 1500 volts and less than 2 ohms at 160 volts output.


TYPE YPD-4
Range 160—1500 Volts

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HIGH OUTPUT (-53db)

Here indeed is *the* crystal microphone of all time—a high-output, unidirectional microphone that ranks far, far above ordinary crystal microphones. Why? Because it is a SUPER-CARDIOID microphone. What does this mean? It means that the "Monoplex" is twice as unidirectional as the Cardioid. It has wide angle pickup across the front of the microphone but it reduces sound pickup from the rear by 15 db—over a broad range of frequencies, and reduces pickup of random sound by 73%! The "Monoplex" employs the same type of acoustic phase-shifting network used in the highest-cost Shure Broadcast microphones. New "Metal-Seal" crystal. The case is pivoted at the rear and can be pointed toward desired sound or upwards for horizontal plane pickup. The "Monoplex" is excellent for high-quality public-address, communications, recording and similar applications. It will operate under adverse conditions of background noise and reverberation where a conventional microphone would be practically useless. Make the most of the "Monoplex"—it is destined for a performance record unique in crystal microphone history!

Manufactured under Shure patents issued and pending. Licensed under patents of Brush Development Co.

SHURE Model "737A" CODE: RUMON List Price: $35.50

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MEMBERSHIP

(Continued from page 41A)

The following admissions to Associate were approved on April 6, 1948, to be effective as of May 1, 1948:

Adams, R. T., 102 Fairmount Ave., Chatham, N. J.
Albert, A. A., 1925 S. Christiana Ave., Chicago 23, Ill.
Alterman, F. J., 25-40—31 Ave., Long Island City, L. I., N. Y.
Andrae, P. H., II, Box 616, Tyndall Field, Fla.
Arnold, T. G., Jr., 3301 St. Paul St., Baltimore 18, Md.
Auerbach, A. A., Eckert-Mauchly Computing Corp., 1215 Walnut St., Philadelphia 7, Pa.
Augustine, A. F., 5216 W. 63 Pl., Chicago 38, Ill.
Austin, H. B., Sandia Base Branch, Albuquerque, N. Mex.
Babin, R. S., 105 Galveston St., S.W., Washington 20, D. C.
Bahli, F., 524 Fourth Ave., Bethlehem, Pa.
Baird, C. W., 2327 Monticello Pl., Columbus 3, Ohio
Baldridge, B. H., R.R. 9, Kratzville Rd., Evansville, Ind.
Barbano, E. J., 14 Highland Ave., White Plains, N. Y.
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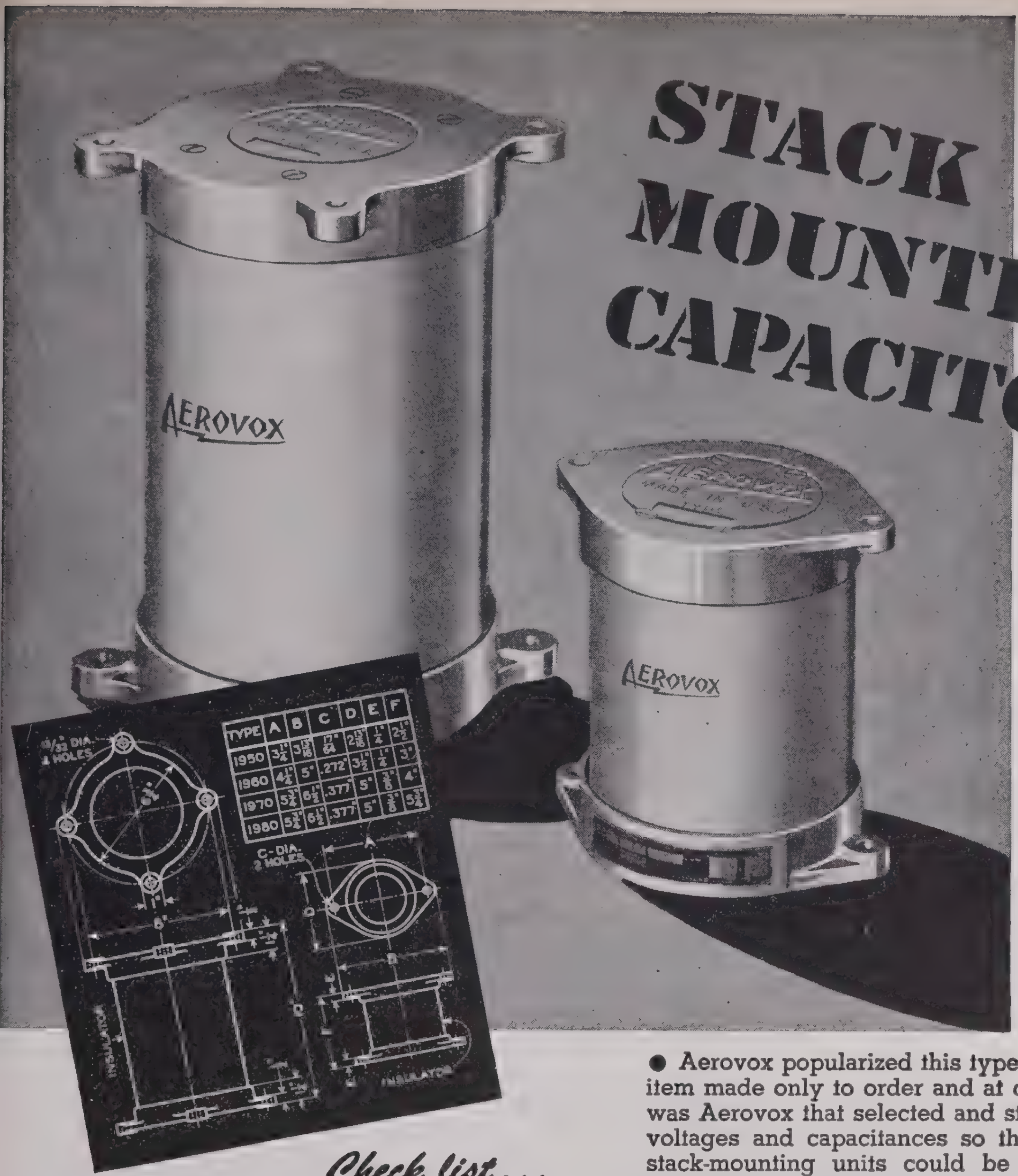

TYPE	A	B	C	D	E	F
1950	$3\frac{1}{4}$"	$3\frac{13}{16}$"	$\frac{17}{64}$"	$2\frac{13}{16}$"	$\frac{1}{4}$"	$2\frac{1}{2}$"
1960	$4\frac{1}{4}$"	5"	.272"	$3\frac{1}{2}$"	$\frac{1}{4}$"	3"
1970	$5\frac{3}{4}$"	$6\frac{1}{2}$"	.377"	5"	$\frac{3}{8}$"	4"
1980	$5\frac{3}{4}$"	$6\frac{1}{2}$"	.377"	5"	$\frac{3}{8}$"	$5\frac{3}{4}$"

STACK MOUNTING CAPACITORS

Check list . . .

- ✓Low-loss glazed ceramic case for long creepage path between terminals.
- ✓Corona losses eliminated on inside and outside alike.
- ✓Cast-aluminum terminal ends for low contact resistance between stacked units.
- ✓Close-tolerance mica units equalize loading of series-connected sections
- ✓Mica sections rigidly clamped in low-loss non-magnetic clamps and heat-treated for maximum capacitance-temperature stability.
- ✓Mechanical design permits units to be stacked and thereby connected in series, parallel and series-parallel. Dummy units are available to support and insulate active units.
- ✓Units may be bolted together through holes in aluminum caps.
- ✓Standard listings; normally available without delay; at the right prices.

● Aerovox popularized this type. Originally a *special* item made only to order and at custom-built prices, it was Aerovox that selected and standardized the sizes, voltages and capacitances so that standard Aerovox stack-mounting units could be regularly produced, listed and properly priced. The rest is history.

Especially intended for various transmitting and electronic applications, these heavy-duty micas have found wide usage in military and peaceful applications alike. Such units are especially popular in heavy-duty transmitting applications such as grid, plate blocking, coupling, tank and by-pass functions. Also in carrier-current applications.

Special yesterday, *standard* today, Aerovox stack-mounting mica capacitors have contributed greatly to available quality equipment and outstanding performance.

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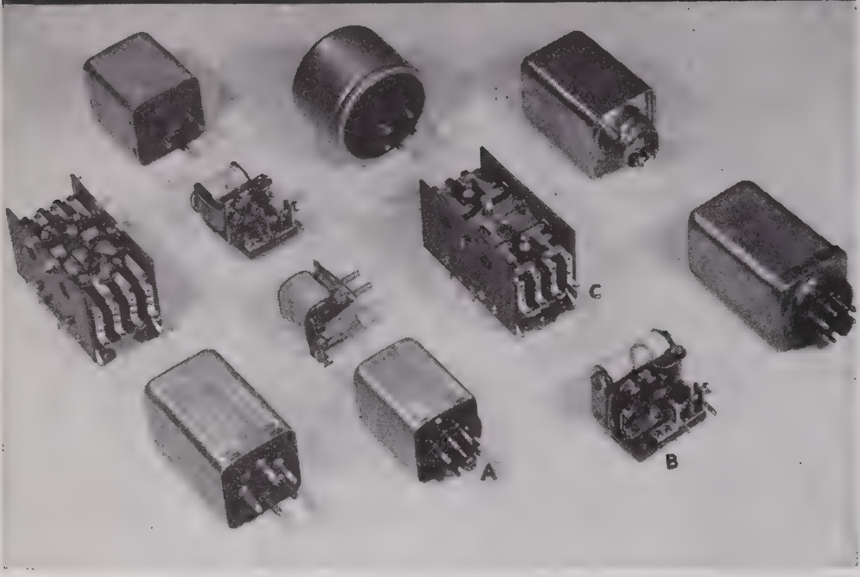

HIGH PERFORMANCE

SPECIAL PURPOSE STANDARD RELAYS

In the preparation of relay specifications for particular functions, cases frequently arise which appear to have widespread occurrence.

We have adopted a policy of listing certain of these special purpose relay specifications as standard, especially when the performance results are exceptionally good.

FOR HIGH-SPEED KEYING OR DIALLING
on low to medium dc power, 50-250 volts supply:

Type 41RO-72327-X (A in cut) List $3.80

- SPDT Relay, 2000 ohm dc coil
- *Operate, 4 ma. or less; 5-10 ma. normal current*
- Contacts: Tungsten (standard) for 0.5 amp or less, moderate to high voltage, long life; fine silver for higher current, lower voltage, moderate life (e.g. 5,000,000).

Typical timing: Milliseconds

Final coil current 7.5 ma *: source	50V	100V	200V
Open N.C. contact	4 ms.	2.5 ms.	1.5 ms.
Transfer to N.O.	1.5	1.0	.7
Open N.O. contact	1.0	1.0	1.0
Transfer to N.C. (Includes Bounce)	3-5	3-5	3-5

*Sufficient external series resistance employed to limit current to this value.

Write for additional data
and timing curves

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- LONG LIFE
- LOW INPUT
- PRE-ADJUSTED

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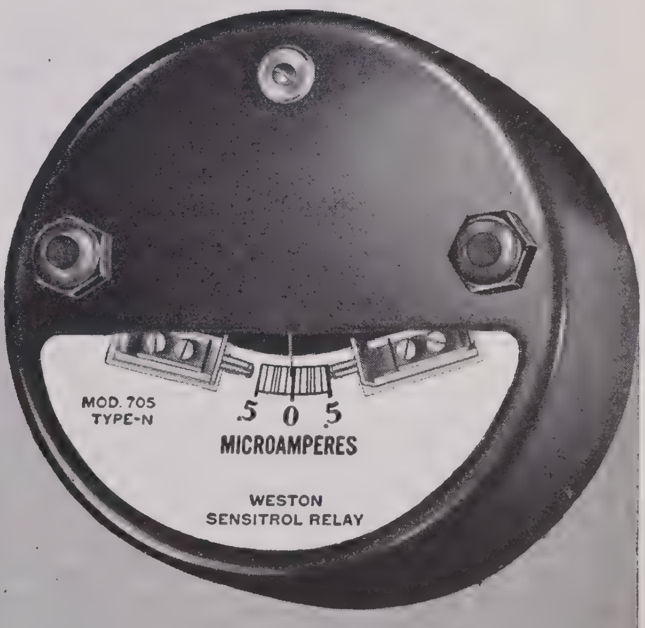
(Continued on Page 46A)

Split 1 microampere in half

each half drives this WESTON *SENSITROL RELAY



Provides positive control at levels as low as ½ microampere. Operates direct from photocells, thermocouples, resistance bulbs, or any suitable electrical circuit. Non-chattering magnetic contacts handle up to 10 watts at 120 volts.

MODEL 705 TYPE N

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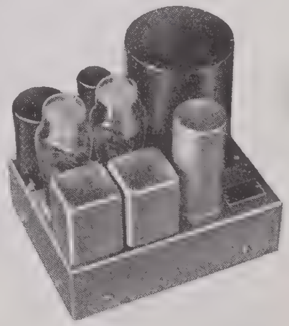
(Continued on page 48A)

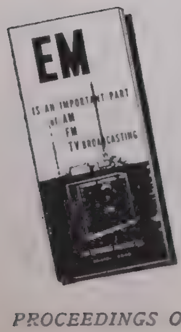
EM IS AN IMPORTANT PART of AM FM TV BROADCASTING

STABILINE Automatic Voltage Regulators Type EM (Electromechanical) are the answer to regulation problems in radio and television transmitting stations . . . high frequency relay stations.

The FCC recommends adequate voltage regulation equipment where the power supplied by the utility varies more than 3% from nominal over a 24 hour period. The STABILINE Voltage Regulator Type EM is ideally suited for this regulation task. Some of the outstanding features include . . . zero waveform distortion, complete insensitivity to the magnitude and power factor of the load, no effect on system power factor, high efficiency and no critical adjustments. Its long-term stability for 24 hour line correction means that Type EM requires negligible attention. Under normal conditions, the output voltage need not be adjusted more than once a month.



The STABILINE Voltage Regulator Type EM consists of an electronic detector circuit controlling a motor-driven POWERSTAT variable transformer. The moving parts are rugged, quality manufactured components which require a minimum of service and attention. The electronic control circuit itself is plug-in type and incorporates the latest advances in detector circuit design. This plug-in feature, combined with the convenient replacement service agreement made at the time of purchase, eliminates maintenance difficulties. The attractive black wrinkle-finished front panel has a 4 inch output voltmeter and screw driver adjustment controls for sensitivity and output voltage setting. Numerous models are available in ratings from 1 KVA to 100 KVA to meet most requirements. Rely on the experience of the Superior Electric Company's staff of voltage control engineers to assist with your voltage regulation problems.



Request Bulletin #448 for detailed information on the STABILINE Type EM and its application in the broadcast field.

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SCHOOL & INDUSTRIAL LAB EQUIPMENT

Kepco Laboratory Multiple Power Supply Model 103, available separately.

Kepco Electronic Instruction Panel Model 104, available separately.

Now you can perform electronic experiments simply, easily with the Kepco Electronic Instruction Panel. Here is a teaching aid that graphically illustrates vacuum tube principles — enables all students to grasp fundamentals in the laboratory.

Extremely versatile, the Kepco Electronic Instruction panel covers a wide range of tubes, comes with a packet of 23 keyed interchangeable circuit charts, 3 master charts and 12 blank keyed sheets for additional experiments. Panel contains 3 octal tube sockets, 18 binding posts. By placing a keyed circuit diagram on the panel and wiring the circuit, students determine tube and circuit characteristics.

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All connections made to sturdy, front panel binding posts.
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16" long, 8" high, 8¾" deep. Wgt.: 28 lbs.

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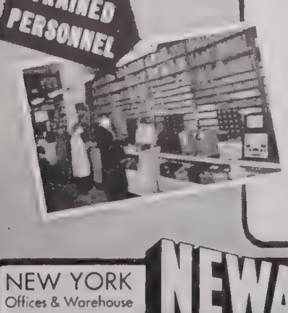

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(Continued on page 56A)

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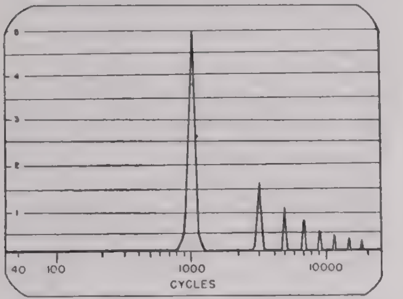
Now, in a matter of seconds, you can observe differences in waveform content produced by parameter variations. Model AP-1 indicates graphically the frequency distribution and amplitude of audio wave components. Slow painstaking point-by-point frequency checks are eliminated. Ease of operation and simplicity of presentation make Model AP-1 ideally suited for production line as well as for laboratory usage.



CHECK THESE FEATURES . . .

• Panoramic graphic presentation of frequency versus voltage amplitude • Continuous scanning from 40-20,000 c.p.s. in one second • Wide voltage range 0.05V to 500V • Simple operation • Direct simultaneous reading of voltage and frequency • Automatic variable selectivity for optimum resolution throughout frequency range (see graph below) • Both linear and log voltage calibrations • Built-in voltage calibrator • Frequency scale closely logarithmic

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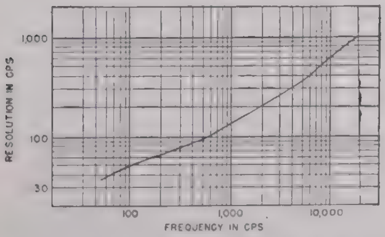

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(Continued from page 54A)

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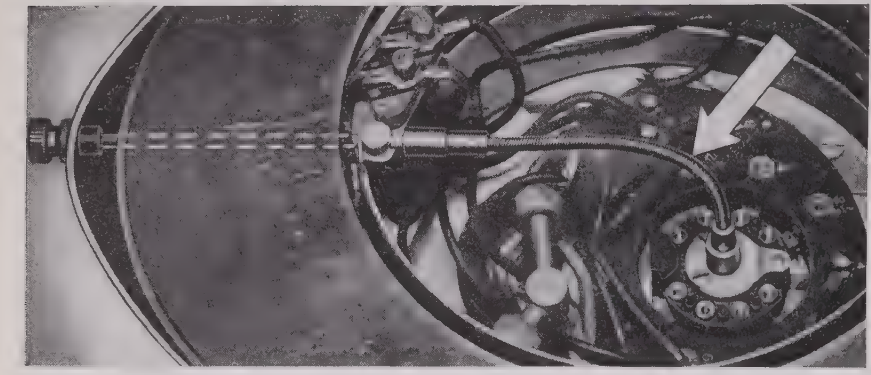
FOR VARIABLE ELEMENTS
with S.S.WHITE
FLEXIBLE SHAFTS



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With S.S.White remote control flexible shafts, developed specially for this service, you can satisfy both.

Above you see a typical example. It's the accessory table of a costly, intricate dental unit shown with cover removed. For reasons of assembly and wiring, the designer located the rotary switch where it is. And he placed the control knob where you see it because it is the most convenient point for operation. Placing both in these positions was no problem—thanks to the S.S.White flexible shaft.

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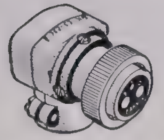
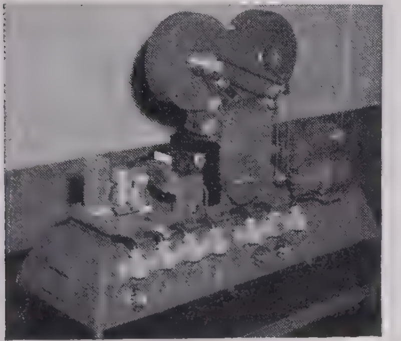
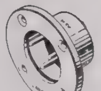
(Continued on page 57A)



Cannon Electric Type K Receptacle on Collins Radio's Antenna Loading Unit. Receptacle shown on unit. Plug type illustrated at left.



Type P Connectors in Reeves' Sound Recorder. Type P Receptacle shown at right.



Installation of AN and K Plugs on Bendix radio equipment installed on the Martin "202" transport.

For a general review of Cannon Plugs, with prices, write for C-47 Catalog or specify engineering bulletin for specific type series.

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(Continued on page 58A)

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PHONES
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- **As an auxiliary signal generator; modulated or unmodulated.**
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Television and FM Test Equipment

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Power Unit: 5⅛″ wide; 6⅛″ high; 7½″ deep. Oscillator Unit: 3¾″ diameter; 2″ deep.

FREQUENCY:
2.2 mc. to 400 mc.; seven plug-in coils.

MODULATION:
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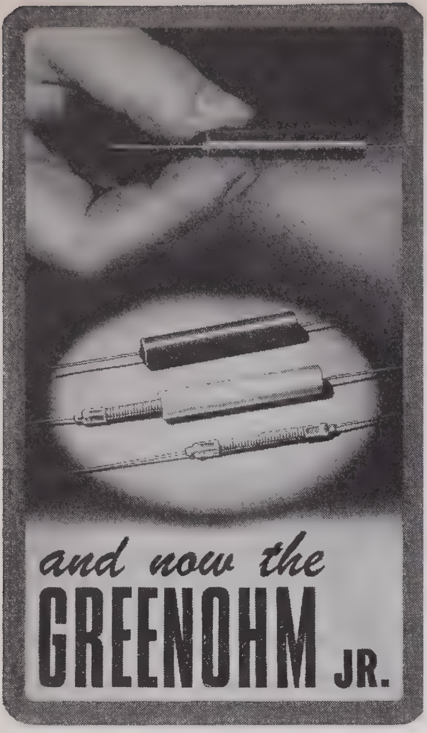
POWER SUPPLY:
110-120 volts, 50-60 cycles; 20 watts.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY



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Wire winding on fibre-glass core. Axial bare pigtail leads clinched to ends. Encased in green steatite tube filled and sealed with exclusive Greenohm inorganic cement. Won't blister, crack or change shape.

Type C7GJ measures 1¾" long by 5/16 dia. 2" leads. 7 watts. Practically zero to 5000 ohms max. Smaller Type C4GJ, 1" long by 5/16 dia. 4 watt. Up to 1000 ohms.

Bulletin No. 110 with complete specs, on request. Also sample. Let us quote.

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News—New Products

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(Continued from page 24A)

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The Pitco adjustable end-link coil, a new design of the **Pittsburgh Coil Co.**, Carnegie, Pa., will operate with high efficiency on a variety of circuits and with beam-power tubes. This new coil can be substituted for the standard end-link model wherever desired. It is readily adjustable by moving the end link with the hand, and is available in 75-, 150-, 250-, and 500-watt sizes.

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(Continued on page 59A)

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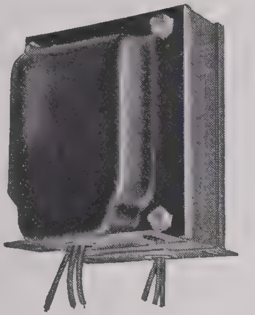
For television, radio, and other electronic applications, Acme produces a wide variety of transformers all with different specifications from standard parts. This means better performance, better quality and often at economy prices.



ENCLOSED TYPES

The dies for making transformers that fit into this enclosed case, alone would cost you thousands of dollars. Acme produces to save you this expense.

Here is a typical air-cooled design which can be produced to meet a variety of applications. Write for Bulletin 168A for further details.

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TRANSFORMERS

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(Continued from page 58A)

Marker Oscillator

Laboratories and manufacturers of television equipment can now obtain accurate alignment of television receivers by using the *Mega-Marker Senior*, which is a 13-channel crystal-controlled marker oscillator developed by **Kay Electric Co.,** Pine Brook, N. J. The crystal accuracy is 0.01%, which is adequate for all needs of television. In addition, it can be used for the alignment of the local oscillator for all thirteen channels. This is accomplished by using the sound channel to furnish an indication of discriminator output. The single-dial control gives a rapid and efficient means of frequency selection without the necessity of consulting charts or calibration curves. The instrument operates on a standard 60-cycle circuit, and weighs 15 pounds. The manufacturer also makes the *Mega-Pipper* and the *Mega-Marker* to facilitate the alignment of i.f. circuits in the same manner that the *Mega-Marker Senior* does the r.f. channels.

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A new line of high-voltage, high-current vacuum capacitors designed for medium- and high-power oscillatory systems is offered by **Dolinko and Wilkens, Inc.,** 101 Hazel St., Paterson 3, N. J. These capacitors feature OFHC copper construction, large-area copper-to-glass seals, and Pyrex bell-shaped envelopes. Vacuum joints are brazed with a high-temperature alloy of low vapor pressure to insure satisfactory operation under heavy loads. The high thermal endurance of the envelope permits exhaust at elevated temperatures and allows attainment of excellent vacuum conditions.

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(Continued on page 60A)

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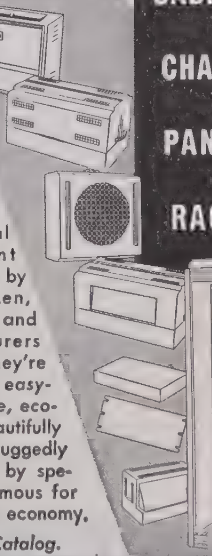

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FM-130 Receiving Antennas

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Without doubt the Premax Adjustable V Dipole Antenna is the most efficient and practical design made to insure maximum FM signal pickup and, because of its design to permit adjustment of the element angle for strongest reception, it permits a sufficient signal energy at the antenna terminals to minimize the importance of the otherwise difficult task of perfect impedance matching.

Write for Bulletin FMT-148, telling why an adjustable V Antenna is best for FM and TV.

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(Continued from page 59A)

Recent Booklets

Interesting engineering and production data on the numerous carbon and graphite specialties produced by **Stackpole Carbon Co.**, St. Marys, Pa., has been combined into an attractive and informative 44-page booklet, "Stackpole Carbon Specialties Booklet," which is available on request. Please use your company's letterhead.

(Continued on page 62A)

FAirmount 5105 EXpress 7766
FRANK MASSA
Electro-Acoustic Consultant
3393 Dellwood Road 3868 Carnegie Avenue
CLEVELAND, OHIO

EUGENE MITTELMANN, E.E., Ph.D.
Consulting Engineer & Physicist
HIGH FREQUENCY HEATING
INDUSTRIAL ELECTRONICS
APPLIED PHYSICS & MATHEMATICS
549 W. Washington Blvd. Chicago 6, Ill.
Phone: State 8021

IRVING RUBIN
Physicist
Radio Interference and noise meters. Interference suppression methods for ignition systems and electrical devices. Laboratory facilities.
P.O. Box 153, Shrewsbury, New Jersey
Telephone: REDBANK 6-4247

ARTHUR J. SANIAL
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FLushing 9-3574

Model 2 B 0.45
(450 MA hr. cap.)
Actual Size Illustrated

RECHARGEABLE • NON-SPILL
VITAMITE
1 OZ. BATTERIES
(Smaller Than 2 Pen-Lights)
IDEAL FOR USE WITH
Miniature And Sub-Miniature Filament Type Tubes
for HEARING AIDS, POCKET RADIOS, ETC.
Other Miniature Models weighing from 1 oz. to 1 lb. also manufactured. All models obtainable in Multi-Units from 2 volts to 120 volts.
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227 West 64th Street New York 23, N.Y.

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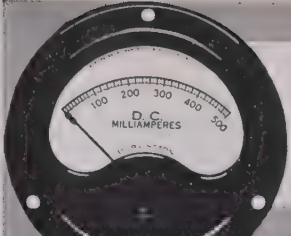
MANUAL DIVISION M-2 MONTCLAIR, N.J.

ONE OF A SERIES



GAUGED ALIGNMENT

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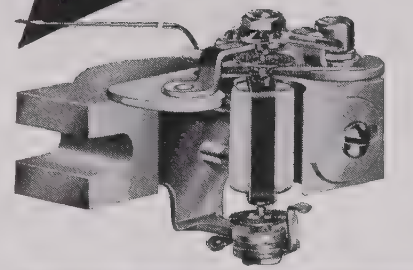

JEWEL SUPPORTS are machined and assembled with aid of precision gauging fixtures to assure perfect alignment. All ranges AC and DC available in 2½", 3½", 4½" rectangular or round case styles and are fully guaranteed for one year against defects in workmanship or material. Refer inquiries to Dept. I 58.

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TWIN Power Supply

Electronically Regulated for Precise Measurements

TWIN POWER SUPPLY
VOLTAGE

Two independent sources of continuously variable D.C. are combined in this one convenient unit. Its double utility makes it a most useful instrument for laboratory and test station work. Three power ranges are instantly selected with a rotary switch:

175-350 V. at 0-60 Ma., terminated and controlled independently, may be used to supply 2 separate requirements.
0-175-V. at 0-60 Ma. for single supply.
175-350 V. 0-120 Ma. for single supply.

In addition, a convenient 6.3 V.A.C. filament source is provided. The normally floating system is properly terminated for external grounding when desired. Adequately protected against overloads.

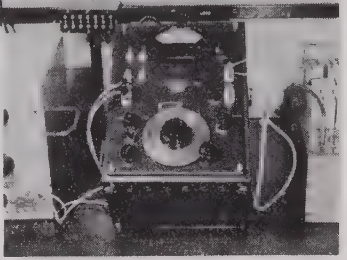
- *Output voltage variation less than 1% with change from 0 to full load.*
- *Output voltage variation less than 1 V. with change from 105 to 125 A.C. Line Voltage.*
- *Output ripple and noise less than .025 V.*

Twin Power Supply Model 210
Complete $130.00
Dimensions: 16" X 8" X 8" Shipping Wt. 35 lbs.
(Other types for your special requirements)
Visit Our Booth No. 286 at the I.R.E. National Convention

FURST ELECTRONICS
North Avenue at Halsted St., Chicago 22, Illinois

Engineering Building, University of Notre Dame

Student Laboratory Measurements
at NOTRE DAME with
Z-ANGLE METERS



One of Notre Dame's Z-Angle Meters

Dr. H. E. Ellithorn, Associate Professor of Electrical Engineering at the University of Notre Dame has this to say about the Z-Angle Meter:

"The Z-Angle Meters have been in use at Notre Dame for the past four months with great success. The meters have been used to find the open circuit and short circuit impedances of artificial lines and cables; clamped and unclamped impedances of telephone receivers; impedances of two terminal balancing networks as a function of frequency and other impedance tests."

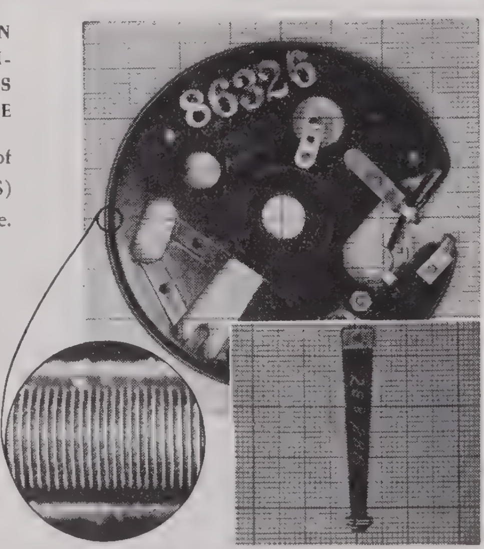
"In the case of the artificial lines and cables, the time necessary to obtain the measurements was reduced to one-half that usually required by ordinary bridge methods."

Write today for Bulletin 508.

TECHNOLOGY INSTRUMENT CORP.
1058 MAIN STREET, WALTHAM 54, MASS.
Midwest Office: Alfred Crossley & Associates, 549 W. Randolph St., Chicago 6, Illinois, State 7444

NEY PRECIOUS METALS IN INDUSTRY

NEY-ORO #28B BRUSH CONTACT ON ADVANCE WIRE WOUND POTENTIOMETER RUNS 4,300,000 SWEEPS WITH NO CHANGE IN RESISTANCE



Mandrel and brush shown 40% full size. Section of mandrel 6⅔ x magnification.

Examine these unretouched photographs of mandrel (wound with Advance #36 B & S) and brush adjusted for 50 gms pressure. There is no appreciable wear on the winding after 4,300,000 sweeps of the brush and the wear on the brush is less than .008″. Throughout the test there was no perceptible change in resistance. Truly a remarkable performance when you consider the additional fact that the test was conducted at a speed of 37.5 cycles (75 sweeps) per minute, considerably faster than normal operation. The test was conducted by a leading manufacturer of precision equipment and the complete test data is available on request. It is, we believe, further convincing evidence of the interesting possibilities offered by the use of Ney Precious Metal Alloys in industrial and scientific applications.

Write or phone (Hartford 2-4271) our Research Department.

NEY GOLD
THE J. M. NEY COMPANY
171 ELM STREET • HARTFORD 1, CONNECTICUT

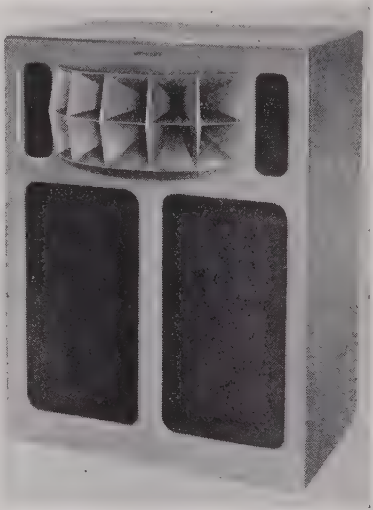
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

30-Watt Speaker

A two-way speaker system designed for installation in the home and described as featuring the same components, engineering standards, and configuration of acoustic baffling as in commercial theater equipment has been recently introduced by **Stephens Manufacturing Corp.,** 10416 National Blvd., Los Angeles 34, Calif. This *Tru-Sonic* speaker is available either in a utility cabinet or a deluxe period cabinet.



The speaker system is rated at 30 watts and consists of two 15-inch 20-watt low-frequency drivers and a 30-watt high-frequency driver. A 10-cell dispersing horn extends the range beyond 15,000 cycles with good efficiency and a high-frequendy attenuator balances room acoustics. The 600-cycle crossover frees the low-frequency drivers of higher-frequency intermodulation or cone breakup. A radical design permits horn loading down to 60 cycles and a special chamber behind the drivers reinforces the bass down to 30 cycles.

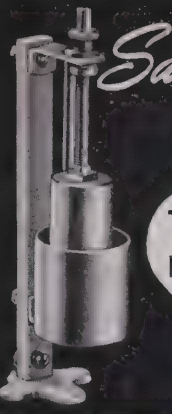
The unit weighs 245 pounds, and is 45 inches high by 36 inches wide by 25 inches deep.

Diamond-Stylus Pickup

A variable-reluctance pickup with a diamond stylus of either 2.5 or 3 mil radius has been announced by the Transmitter Division of **General Electric Co.,** Electronics Park, Syracuse, N. Y. It is designed especially for broadcast-station lateral reproduction and provides substantial discrimination against noise due to vertical pickup.

A transcription arm, which is available for use with this pickup, is equipped with cone-face ball bearings for smooth movement on both the vertical and horizontal axes.

(Continued on page 63A)



THE JOHNSON
N250 CONDENSER

Extremely High Voltage Rating In Proportion To Size

When space is limited, yet you need extremely high voltage rating, fine adjustment with uniform voltage breakdown rating throughout the full capacity range, the JOHNSON Type N Neutralizing Condenser is the perfect answer.

Because of their desgin, these condensers will withstand much higher voltage than conventional flat plate condensers of the same spacing.

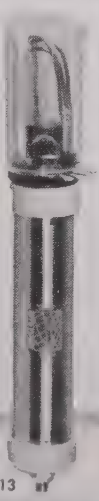
High in quality—low in cost, JOHNSON condensers are always a wise choice.

For Complete Details Write For
Latest JOHNSON Catalog

E. F. JOHNSON CO.
WASECA, MINNESOTA

ACCELEROMETER TRANSDUCERS

Unique linear Acceleration Transducers . . . Measure the acceleration of launching and additional thrust and the deacceleration of aerodynamic drag. These instruments provide large electrical potentiometer-type outputs proportional to acceleration Magnetically damped with ranges from ±5 G's to ±100 G's. The type 2414 provides expansion of potentiometer output for special ranges. Standard resistance for these instruments is 5,000 ohms.


Type 2413

Write for complete information

G. M. Giannini & CO INC
REACTION POWER PLANTS • AUTOMATIC FLIGHT EQUIPMENT
285 WEST COLORADO STREET • PASADENA 1, CALIFORNIA

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 62A)

Vacuum Coating Unit

A table-model vacuum unit with a Pyrex bell jar 7 inches in diameter and 10 inches high, capable of attaining a pressure of 0.1 micron, is announced by **Distillation Products, Inc.,** 755 Ridge Road West, Rochester 13, N. Y. The unit includes mechanical and oil-diffusion pumps, a Pirani gauge, four electrodes, and a power circuit. When charged with a nonvaporizing load, the bell jar will attain a vacuum of 3×10^{-4} in less than twenty minutes, and will reach 1×10^{-4} under an hour.

This unit may be used for such applications as coating lenses and mirrors with low reflecting surfaces, preparing surface replicas for the electron microscope, metal evaporation, and demonstrations of electronic experiments.

Miniature Wet Battery

VITAMITE
2.2 VOLTS
WET CELL
THE VITAMITE COMPANY

This new rechargeable battery, manufactured by **Vitamite Co.,** 227 W. 64th St., New York 23, N. Y., is completely spillproof since all free-flowing electrolyte has been eliminated. It is smaller than two penlight dry cells, but it delivers 50% more wattage than two type "C" dry cells upon a single charging. It is made leakproof by being enclosed in a one-piece molded-plastic case, which measures 1 13/16×7/8×9/16 inches and weighs 1 ounce. Each is rated at 2.2 volts, and maintains this voltage steadily through 95% of the usable life of any one charging. As delivered by the manufacturer, the battery may be placed upon the shelf indefinitely, due to its dry charge without loss of the original charge until used.

These batteries are ideal for use in pocket radios, hearing aids, photographer's flash guns, walkie talkies, and flashlights. The manufacturer also makes the charging units and similar batteries in multiple units.

(Continued on page 65A)

ANOTHER New BROWNING DEVICE

CAPACITANCE RELAY
MODEL DD-20

Super-sensitive "brain" for alarm, safety, or signal systems. Operates alarm circuit on capacitance changes of 0.25 mmfd.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

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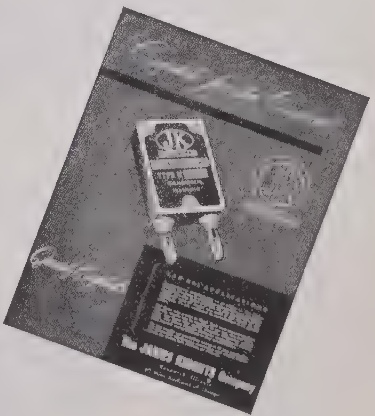
BROWNING LINE
ENGINEERED for ENGINEERS

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

OFF PRESS!



THE NEW JAMES KNIGHT
CRYSTAL CATALOG

You'll want a copy of the new James Knights catalog of "Stabilized" crystals. It contains photos and specifications of many new crystals, crystal ovens, holders, including new filter crystals with standard RMA pigtails. If your distributor cannot supply you, write for your free copy direct.

THE JAMES KNIGHTS CO.
Sandwich, Illinois

AMPERITE
MICROPHONES

The ultimate in microphone quality, the new *Amperite Velocity* has proven in actual practice to *give the highest type of reproduction in Broadcasting, Recording, and Public Address.*

The major disadvantage of pre-war velocities has been eliminated—namely "boominess" on close talking.

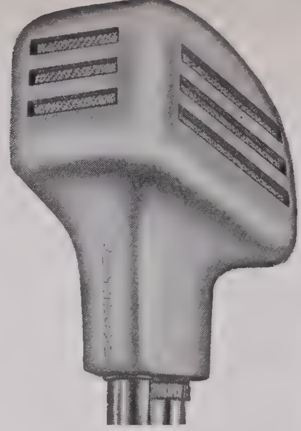
- *Shout right into the new Amperite Velocity—or stand 2 feet away*—the quality of reproduction is always excellent.
- *Harmonic distortion is less than 1%.* (Note: best studio diaphragm mike is 500% higher.)
- *Practically no angle discrimination . . . 120° front and back.* (Best studio diaphragm microphones . . . discrimination 800% higher.)
- One Amperite Velocity Microphone will pick up an entire symphony orchestra.

STUDIO VELOCITY, finest in quality; ideal for Broadcasting and Recording.

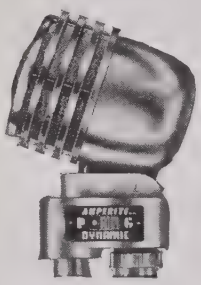
Models R80H-R80L . . List $80.00

There is an Amperite Microphone for every requirement.

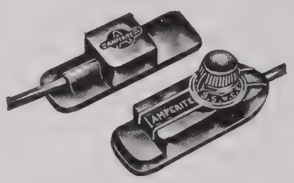
WRITE FOR ILLUSTRATED 4-PAGE FOLDER giving full information and prices.



Amperite
Velocity Microphones
for Public Address
Models RBHG, RBLG
List $42.00



P.G. Dynamic
Models PGH, PGL
List $32.00



"Kontak" Mikes
Model SKH, list $12.00
Model KKH, list $18.00

Address inquiry
attention Dept.
I.R.E.

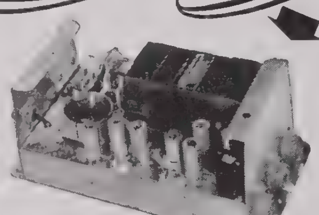
AMPERITE Company, Inc.
561 BROADWAY NEW YORK 12, N. Y.

In Canada:
Atlas Radio Corp.
560 King St. W.
Toronto, Ont.

"A Well Known Name in Radio for Over 25 Years"

NO.
6
OF A SERIES

Carter powers "Taxi Talkie" Communications Equipment



To provide ample and instant power for their two-way mobile radio system, MOBILE COMMUNICATIONS COMPANY uses the famous CARTER GENEMOTOR shown in the chassis illustrated here. These CARTER units are designed to deliver 100,000 transmissions without servicing. Quick power too—trigger fast! Flick the switch and in 3/10 of a second the Taxi Talkie system surges with power!

For illustrated catalog, specifications and technical data on CARTER rotary power supplies, and name of nearest CARTER distributor, WRITE TODAY.

Carter Motor Co.
Chicago, Illinois

2645 N. MAPLEWOOD AVENUE • CABLE: GENEMOTOR

Attention
Associate Members!

Many Associate Members can qualify for higher membership grades and should certainly do so. Members are urged to keep membership grades up in pace with their present development.

An Associate over 24 years of age who is occupied as a radio engineer or scientist, and is in this active practice three years may qualify for Member Grade.

An Associate who has taught college radio or allied subjects for three years may qualify.

Some may possibly qualify for Senior Grade. But transfers can be made only upon your application. For fuller details request transfer application-form in writing or by using the coupon below.

Coupon

Institute of Radio Engineers
1 East 79th St.,
New York 21, N.Y. 5-48

Please send me the Transfer Application Membership-Form.

Name ....

Address ....

Place ....

State ....

Present Grade ....

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 63A)

Synchronizing Generator

The smallest commercially available television synchronizing generator is announced by the Television Transmitting Equipment Division, **Allen B. Du Mont Labs., Inc.,** 42 Harding Ave., Clifton, N. J. Notwithstanding its diminutive size and weight, it has been engineered for inherent stability, high performance standards and ease of operation to make it ideally adapted to field use. In addition, it can serve as the source of synchronizing signals for all types of television work, such as testing transmitters, experimental television development and laboratory work of an allied nature.

Completely self-contained, this equipment requires only a.c. power. It provides mixed driving, blanking and synchronizing signals. The master oscillatory can be locked to the 60-cycle line or run completely free. It provides half-line driving pulses for utilization of differential delay techniques necessary for long camera cable hookups. Stability of countdown and pulse width of composite signal are essentially independent of tube changes. Regulated power supplies make the unit independent of line-voltage variations.

P.M. Speakers

A new line of permanent-magnet speakers for replacement service has been announced by **Zenith Radio Corp.,** 6001 W. Dickens Ave., Chicago 39, Ill. Popular sizes of speakers ranging from 3½ to 12 inches, in all magnet weights, are included. A 6×9 inch p.m. speaker has been made available because of the large quantities used in post-war automobile receivers. Accompanying the speakers are thirteen transformers which will supply nearly all transformer replacement needs.

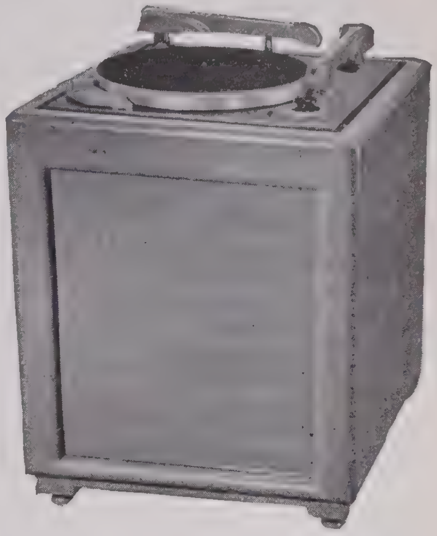
Recent Booklets

A new line of small electron tubes, "Special Red" tubes, for industrial and commercial applications where extreme dependability, long life, and resistance to vibration are essential is described in a technical booklet, RSB1000, by the Commercial Engineering Section of the Tube Dept., **Radio Corp. of America,** Harrison, N. J. These tubes are similar in electrical characteristics to their receiving tube counterparts, the 6SL7-GT, 6SN7-GT, and 6SJ7.

(Continued on page 66A)

RMC TRANSCRIPTION CONSOLES

Judged by Quality . . . Durability and Dependability . . . not their LOW PRICE



Advanced style and in attractive gray finish to harmonize with any interior. Furnished with or without RMC Reproducers, Amplifiers, and Turntables, as desired. Turntables of completely new design.

Model illustrated shows the Vertical Only and Lateral Only combination Reproducers with Type TP-16E Turntable mounted in Type BS1 Console, complete $399.00 F.O.B. Port Chester, N.Y.

Other RMC Transcription Consoles and various combinations, as required, are available.

Write for descriptive, illustrated Bulletin TC-51 which lists prices for many other combinations.

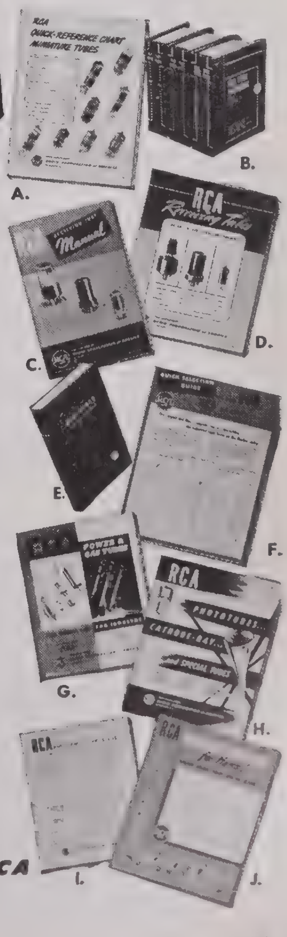
Price subject to change without notice

Sold through local jobber

Export: Rocke International Corporation, 13 East 40th Street, New York 16, New York

RADIO-MUSIC CORPORATION
PORT CHESTER • NEW YORK

KEEP POSTED ON ELECTRON TUBES



Use this convenient coupon for obtaining the RCA tube reference data you need.

RCA, Commercial Engineering,
Section EW52, Harrison, N.J.

Send me the RCA publications checked below. I am enclosing $........ to cover cost of the books for which there is a charge.

Name____________________________

Address___________________________

City______________Zone_______State________

- ☐ Quick-Reference Chart, Miniature Tubes (*Free*). [A]
- ☐ HB-3 Tube Handbook (*$10.00*)*. [B]
- ☐ RC-15 Receiving Tube Manual (*35 cents*). [C]
- ☐ Receiving Tubes for AM, FM, and Television Broadcast (*10 cents*). [D]
- ☐ Radiotron Designers Handbook (*$1.25*). [E]
- ☐ Quick Selection Guide, Non-Receiving Types (*Free*). [F]
- ☐ Power and Gas Tubes for Radio and Industry (*10 cents*). [G]
- ☐ Phototubes, Cathode-Ray and Special Types (*10 cents*). [H]
- ☐ RCA Preferred Types List (*Free*). [I]
- ☐ Headliners for Hams (*Free*). [J]

**Price applies to U. S. and possessions only.*

TUBE DEPARTMENT
RADIO CORPORATION of AMERICA
HARRISON, N. J.

DIALCO

PILOT LIGHT ASSEMBLIES

PLN SERIES—Designed for NE-51 Neon Lamp

Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
- 110 or 220 VOLTS
- EXTREME RUGGEDNESS
- VERY LOW CURRENT

Write for descriptive booklet

The DIAL LIGHT CO. of AMERICA
FOREMOST MANUFACTURER OF PILOT LIGHTS
900 BROADWAY, NEW YORK 3, N. Y.
Telephone—Spring 7-1300

Sign of Transformer Reliability

KENYON For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!

Consult KENYON about your transformer problems.

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

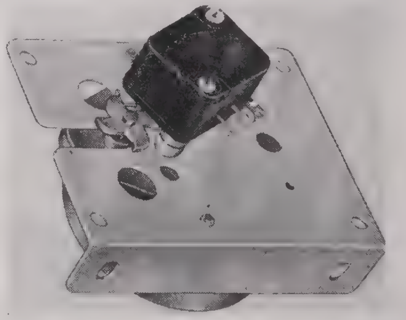
(Continued from page 65A)

Resistor Analysis Council

A special service to design engineers working with resistor problems is offered by **International Resistance Company,** 401 North Broad Street, Philadelphia 8, Pa. Headed by Wm. H. Knowles, Jr., a group of this firm's engineers have formed the "Resistor Analysis Council" to review and make recommendations on resistor requirements in any circuit. Upon request the design engineer will be supplied with a resistor specification sheet, which, when filled out, organizes the many elements of the problem in a remarkably complete, clear and helpful fashion; and makes it easier to determine where standard resistors can be used effectively.

Light-Duty Interrupter

With applications in the communications field where signals of set length, repeated regularly, are required, the **Haydon Manufacturing Company, Inc.,** 245 East Elm Street, Torrington, Conn., announces their series 5400 interrupters, shown below:



Ranging from 72 pulses or flashes per minute, each of 0.4 second in length, to 1 pulse every two minutes, of one minute duration, the unit is composed of a timing motor, assembled with a 4-lobe cam, steel wire cam follower and peanut Micro-switch. A synchronous timing motor drives the cam at constant speed, and current is fed intermittently to the controlled circuit in equal on and off periods, with an accuracy of plus or minus 20% depending on load and voltage conditions. The unit is only 3″ high, $2\frac{5}{16}''$ wide by $2\frac{1}{8}''$ deep.

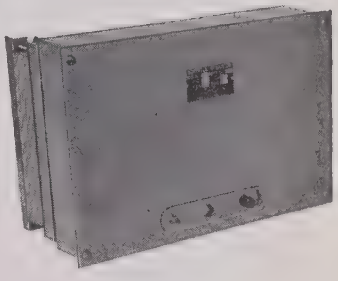
New Shakeproof Terminal Catalog

Useful to the design engineer is the very complete 72-page catalog just issued by **Shakeproof Inc.,** 2501 N. Keeler Avenue, Chicago 39, Ill. Catalog A-S-51 covers the entire line of locking and plain terminals offered by this firm, and the illustration method and design data and cataloging is particularly clear and useful.

Self Control—

—of AC; DC or RF outputs in any one circuit, selectively stabilized over wide ranges of line and load with the new SORENSEN ELECTRONIC CONTROLLER

The AC output of the CONTROLLER will swing between 85-145 VAC, AUTOMATICALLY adjusting the output of your unit against line and load variations. By referencing this output back to the CONTROLLER you get output regulation.



TECHNICAL SPECIFICATIONS

The controlled circuit must make available at least one watt of power to the CONTROLLER.

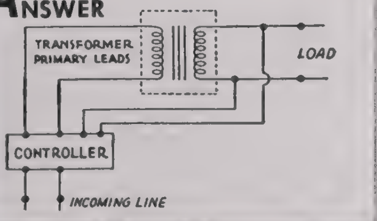
Input voltage range:	95-125 volts AC (50 or 60 cycles)
Load range:	200 to 2000 VA
Regulation accuracy:	0.5% at the controlled point

write today for more information on the new CONTROLLER. Arrange to have a Sorensen Engineer analyze voltage regulation requirements in your plant. He can select a Sorensen unit or suggest a special design to fit your unusual application.

Here's how the CONTROLLER answers typical regulation problems

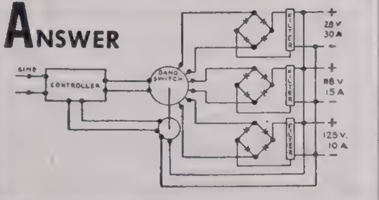
Q. An AC requirement. Can you stabilize the output of a transformer?

ANSWER


TRANSFORMER PRIMARY LEADS
LOAD
CONTROLLER
INCOMING LINE

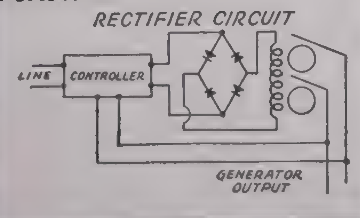
Q. Can you selectively regulate a number of DC voltages and currents?

ANSWER


LINE
CONTROLLER
BAND SWITCH
FILTER
FILTER
FILTER
+
28 V
30 A
−
+
88 V
15 A
−
+
125 V.
10 A
−

Q. Can the CONTROLLER stabilize a generator field to regulate its output?

ANSWER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GENERATOR OUTPUT

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& COMPANY, INC. • STAMFORD, CONNECTICUT

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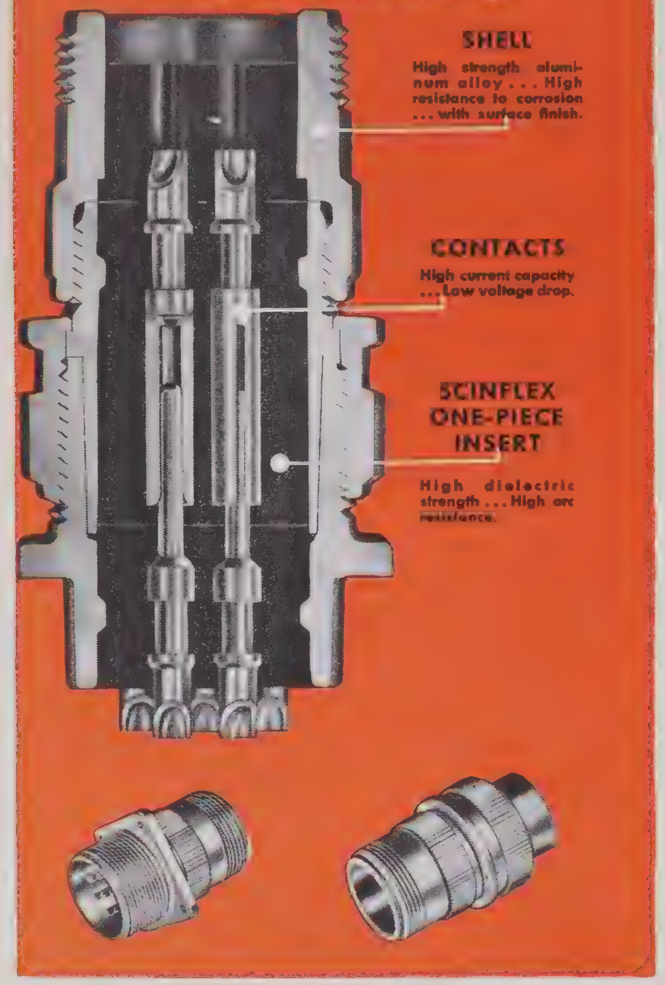
the finest ELECTRICAL CONNECTORS
money can build or buy!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High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High arc resistance.

AND THE SECRET IS SCINFLEX!

Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

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*REG. U.S. PAT. OFF.

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Available in all Standard A.N. Contact Configurations

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SCINTILLA MAGNETO
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DIVISION OF
Bendix
AVIATION CORPORATION

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Laboratory Amplifier with Dynamic Noise Suppressor

The Type 210-A laboratory amplifier, offered by **Hermon Hosmer Scott, Inc.**, Dept. IR, 385 Putnam Ave., Cambridge, Mass., uses the dynamic-band-pass principle to reach new peaks of performance. In addition to reproducing phonograph records, the amplifier may be used with any standard tuner, and is designed to provide quality reproduction of phonograph records, f.m., or a.m.

This unit, supplied with a matched variable-reluctance pickup cartridge, provides a complete phonograph system except for turntable or record changer and loudspeaker. The amplifier provides 20 watts output with less than 2% distortion, and below 8 watts, the distortion is under ½%. The output transformer is arranged to match speaker impedances between 2 and 500 ohms.

The maximum frequency range of the amplifier exceeds 20,000 c.p.s. With the dynamic noise suppressor the response is flat to 10,000 c.p.s. and extends to 16,000 c.p.s. Independent tone controls allow boost or attenuation at either end of the frequency range. A whistle filter is provided for a.m. reception.

Recent Catalogs

• • • On television antenna problems in apartment houses, hotels, and other multiple television set buildings, by **Amy, Aceves & King, Inc.**, 11 West 42 St., New York 18, N. Y.

• • • On "a new basically improved line of general speakers" for reproducing 16-mm sound on film. A two-color illustrated folder by **Altec Lansing Corp.**, New York and Hollywood. The new models are 604B Duplex, 603B Multicell Diacone, 600 B Diacone, and a new edition to the line, an 8" Diacone.

• • • On a new line of metered variable transformers manufactured by **Standard Electrical Products Co.**, 400 Linden Ave., Dayton 4, Ohio. This new group includes isolated primary transformers with secondary voltages from 0–140 volts, also auto-type transformers with the same output voltage.

(Continued on page 55A)

How many of these *practical* ideas can YOU use?

Free!
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PRACTICAL IDEAS
for metal problems
in electrical products

Here's an opportunity to learn how other electrical manufacturers solve metal selection problems—problems you yourself may have to solve.

This brand-new, illustrated collection of ideas shows you in detail how INCO Nickel Alloys resist high temperatures, corrosion, fatigue, abrasion—how their special properties are useful in scores of applications.

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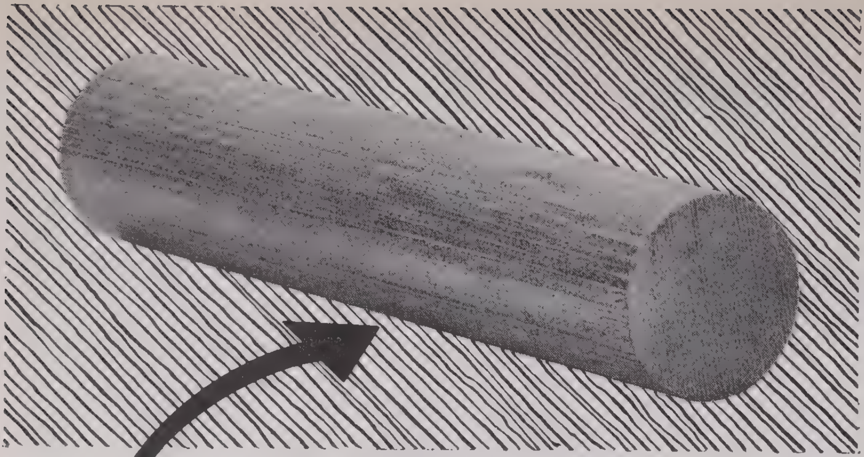

FROM ROD STOCK
TO SUPPORT BLOCK

That smooth cylinder of Taylor Phenol Fibre pictured above doesn't appear very complex.

But with a few deft motions in the machine shop, it becomes the hinge support block shown below . . . intricate, carefully engineered, highly specialized.

Sheets, rods, and tubes of Taylor Laminated Plastics, in various formulations, are serving industry in more ways every day. Their machineability is a paramount factor.

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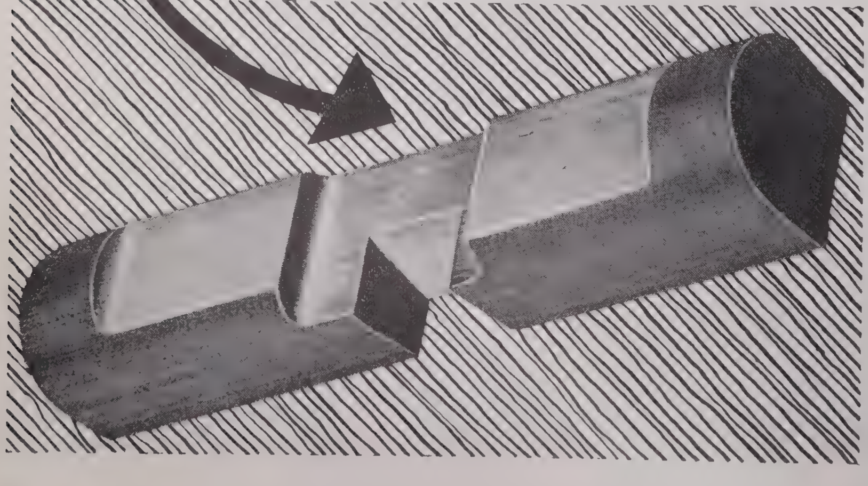


SECTION MEETINGS

BALTIMORE

"Coaxial Cable Transmission Systems," by J. A. Wood, American Telephone and Telegraph Company; March 16, 1948.

BEAUMONT-PORT ARTHUR

"Radio-Frequency Heating," by R. H. Schneider, Westinghouse Electric Corporation; March 16, 1948.

BOSTON

"The Betatron and Synchrotron," by I. A. Getting, Massachusetts Institute of Technology; March 25, 1948.

BUFFALO-NIAGARA

"Bessell Functions and other Screwball Concepts," by M. G. Nicholson, M. C. Scott, and R. W. Carlson, Colonial Radio Corporation; February 18, 1948.

"Pulse-Time Telemetering," by N. L. Harvey, Sylvania Electric Products Company; March 17, 1948.

CEDAR RAPIDS

"Traveling-Wave Tubes," by J. R. Pierce, Bell Telephone Laboratories; March 26, 1948.

CINCINNATI

"Magnetic Recording," by M. Camras, Armour Research Foundation; March 16, 1948.

CONNECTICUT VALLEY

"Applications of Sweeping Oscillators in Test Equipment," by F. C. Marble, Kay Electric Company; April 14, 1948.

DALLAS-FORT WORTH

"Photoelectric Calorimeter," by P. L. Harton, Southern Methodist University; March 15, 1948.

"Peacetime Uses and Economics of Atomic Power," by P. M. Thorp, Southern Methodist University; March 15, 1948.

"Expressiveness in Engineers," by J. C. Horney, Southern Methodist University; March 15, 1948.

"Distributed Amplification," by W. R. Hewlett, Hewlett Packard Company; March 31, 1948.

DAYTON

"The Univac Electronic Computer," by J. W. Mauchly, Electronic Control Company; March 11, 1948.

"Bandwidth Reduction in Communications Systems," by W. G. Tuller, Melpar, Inc.; March 31, 1948.

"R.F. Tuners for Television and F.M.," by R. Romero, Radio Corporation of America; April 8, 1948.

DETROIT

"Some Equipment and Systems Aspects of Engineering Radio Communications," by L. P. Morris, Communication and Electronics Systems Division of Motorola, Inc.; March 19, 1948.

EMPORIUM

"Printed Circuits and Miniature Electronics," by C. Brunetti, National Bureau of Standards; January 14, 1948.

HOUSTON

"Induction and Dielectric Heating," by R. H. Schneider, Westinghouse Electric Corporation; March 15, 1948.

"Distributed Amplification," by W. R. Hewlett, Hewlett-Packard Company; April 1, 1948.

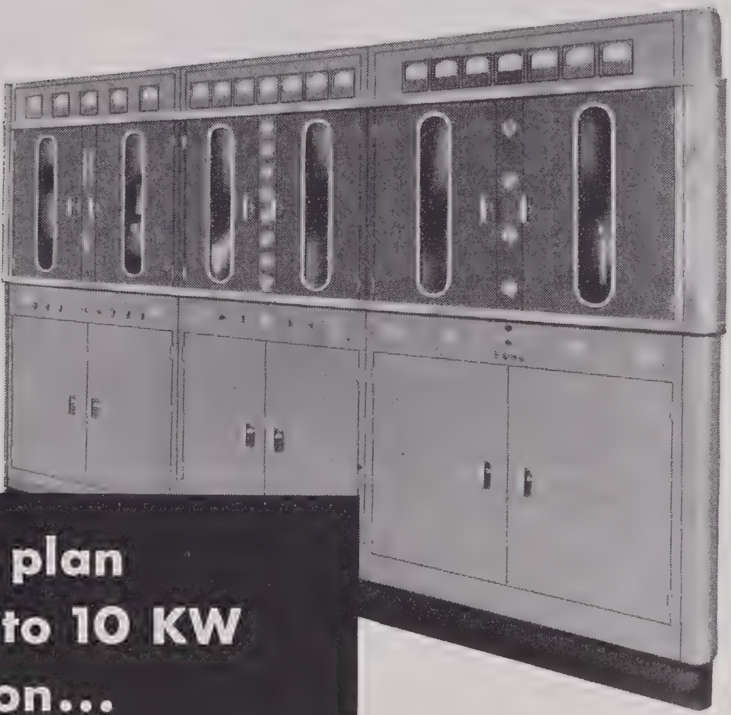
INDIANAPOLIS

"Civilian Use of Subminiature Tubes," by W. R. Jones, Sylvania Electric Products Company; February 20, 1948.

(Continued on page 36A)

If you want a 5 KW AM Transmitter right away...

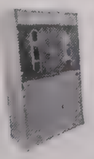
... you can get immediate shipment from stock on the famous Western Electric 405B-2 utilizing the Doherty high-efficiency circuit.



If you plan to step up to 10 KW later on...

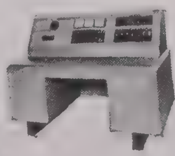
...you can order a complete conversion kit for change-over in the field. Kits are available also to present users of the 405B-1 and 405B-2.

AUXILIARY EQUIPMENT FOR USE WITH THE 405B-2 5 KW TRANSMITTER



33C ANTENNA CONTROL UNIT

Identical in styling with the 405B-2 Transmitter, the 33C controls, under power, the relative magnitude and phase relation of the element currents in a two-tower antenna system. 34A Antenna Phase Control Units may be added for control of a larger number of towers.



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Incorporates volume indicator panel, monitor amplifier, meter panel, audio line and announce control panel, power switch panels for controlling transmitter circuits.

When you buy a Western Electric 405B-2 5 kw AM Transmitter, you get these outstanding advantages:

The Doherty *high-efficiency* circuit permits attainment of *extremely low* noise, harmonic distortion and intermodulation distortion. The negligible carrier shift assures full utilization of assigned carrier power.

With low level modulation, no damage will result if the transmitter should be heavily overmodulated with either interrupted or continuous tone at any audio frequency, *even for extended periods.*

Compact design permits installation in relatively small space. Modern styling harmonizes with any architectural treatment.

You get these—and many other features—when you buy a 405B-2. And ... you can get one *without waiting*—convert it later to 10 kw if you step up your power! For full information, call your local Graybar Broadcast Representative —or write Graybar Electric Company, 420 Lexington Ave., New York 17, N. Y.

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WSAV Truscon Radio Tower STANDS UP
IN 100 MILE-AN-HOUR HURRICANE!

● On October 15, 1946, a tropical hurricane struck with tremendous force on Whitemarsh Island, Savannah, Georgia, location of WSAV's FM installation. Wind velocities were estimated in excess of 100 miles per hour.

Inspection of the Truscon Radio Tower immediately after the storm showed there was no damage to the antenna or tower. The surrounding area suffered great damage. The ability of this structure to STAND UP under such severe punishment is a fitting tribute to the balanced design, quality materials and skilled workmanship built into Truscon Radio Towers.

Truscon experience encompasses every modern radio tower need. There are hundreds of Truscon Radio Towers in America and foreign lands, operating in a wide range of wind, temperature and humidity conditions. The knowledge gained from such a diversity of installations assures you highly competent engineering service.

Truscon Radio Towers are available in guyed or self-supporting types, either tapered or uniform cross section, for AM and FM broadcasting. Experienced Truscon radio tower engineers will be glad to help solve your radio tower problems of today and tomorrow.

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YOUNGSTOWN 1, OHIO
Subsidiary of Republic Steel Corporation

TRUSCON SELF-SUPPORTING AND UNIFORM CROSS SECTION GUYED TOWERS

SECTION MEETINGS

(Continued from page 34A)

"Components for Magnetic Recording," by T. E. Lynch, Brush Development Company; February 27, 1948.

"V.H.F. Direction Finders," by A. G. Richardson, Federal Telecommunications Laboratories; March 12, 1948.

"Avenues of Improvement in Present-Day Television," by D. G. Fink, *Electronics*; March 12, 1948.

LONDON (CANADA)

"Interference in f.m. Links," by R. W. Cooke, University of Western Ontario; March 5, 1948.

"A Vector Cardioscope," by S. Kostashuk, University of Western Ontario; March 5, 1948.

"Analysis of Wave Forms," by G. Lang, University of Western Ontario; March 5, 1948.

"Power Metering," by R. McNarry, University of Western Ontario; March 5, 1948.

"Configuration of Electrostatic Fields in Electron Lenses," by G. Harrower, University of Western Ontario; March 5, 1948.

"Frequency Allocation and Rulings Arising Out of the Atlantic City Conference," by J. C. Burbank, Royal Canadian Air Force; April 2, 1948.

LOS ANGELES

"A 50,000-Watt F.M. Transmitter for 100.5 Megacycles," by R. L. Norton, Eitel-McCullough, Inc.; March 16, 1948.

"Television Receiver Sound System," by A. A. Barco, RCA Industry Service Laboratory; March 16, 1948.

LOUISVILLE

"Atomic Energy, Tool or Weapon," by J. E. Reilly, Westinghouse Electric Corporation; March 12, 1948.

MILWAUKEE

"Understanding Twentieth Century Art," by G. B. Cumming, Milwaukee Art Institute; February 11, 1948.

"Progress in the Electric Power Rectifiers and Invertors," by W. E. Gutzwiller, Allis-Chalmers Manufacturing Company; March 10, 1948.

NEW YORK

"Metallic Dielectrics and Lenses for Microwaves," by W. E. Kock, Bell Telephone Laboratories; April 7, 1948.

OTTAWA

"Electronics in Atomic Energy Research," by N. F. Moody, National Research Council; March 11, 1948.

"Tasks for the Radio Engineer for the Army in the Field," by A. E. Wrinch, Ottawa Army Headquarters; March 25, 1948.

"Development of Atomic Power," by B. R. Prentice, General Electric Company; April 6, 1948.

PHILADELPHIA

"Microwave Spectroscopy," by D. K. Coles, Westinghouse Research Laboratories; April 1, 1948,

PORTLAND

"Audio-Frequency Response Measurements", by A. E. Richmond, Radio Station KALE; March 31, 1948.

"A Distributed Amplifier," by A. P. Copson, Oregon State College; April 10, 1948.

"An Electronic Watch Analyzer," by J. W. Moulton, Oregon State College; April 10, 1948.

PRINCETON

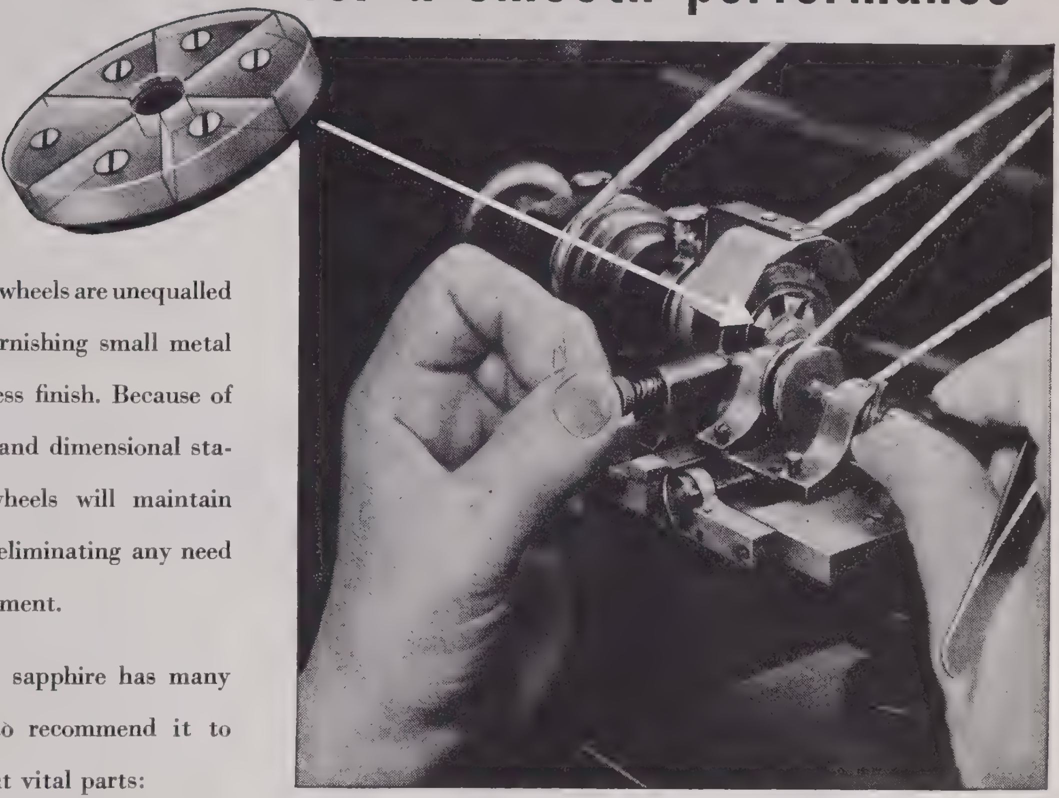
"Radio Observations in the Field of Astronomy," by J. L. Pausey, Council for Scientific and Industrial Research (Sydney, Australia); March 4, 1948.

"High Energy Electro-Nuclear Accelerators," by M. G. White, Princeton University; April 8, 1948.

(Continued on page 38A)

Synthetic Sapphire

for a smooth performance



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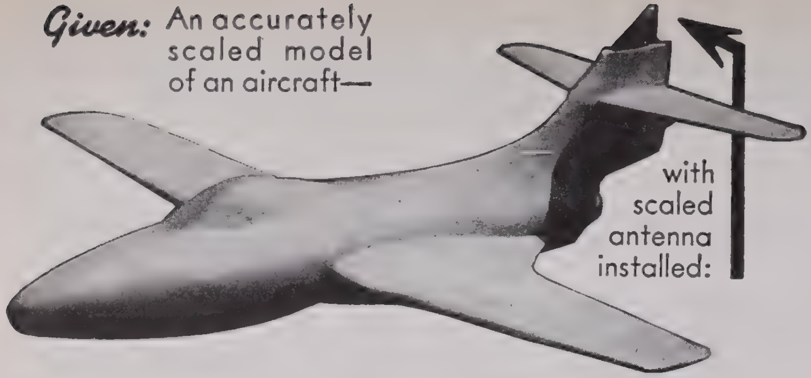


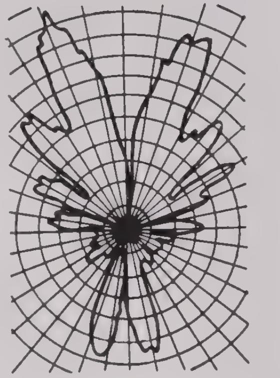
with scaled antenna installed:

Find: The radiation pattern of that antenna on that aircraft in any plane and for either vertical or horizontal polarization.

Solution: With a three-man crew to operate it, our

Type 105
Aircraft Antenna Pattern
Plotting System

can measure and record more than 100 such radiation patterns in a routine working day.



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SECTION MEETINGS

(Continued from page 36A)

ROCHESTER

"Electronic Digital Computers," by A. W. Tyler, Eastman Kodak Company; March 18, 1948.

"Present Status of Television Broadcasting," by R. E. Shelby, National Broadcasting Company; April 15, 1948.

SACRAMENTO

"Latest Developments of Radar and Microwave Radio Equipment," by J. O. Perrine, American Telephone and Telegraph Company; March 31, 1948.

ST. LOUIS

"Elements of Magnetic Recording," by C. T. Lynch, Brush Development Company; March 25, 1948.

"Safety in Aircraft Flight," by L. F. Jones, Radio Corporation of America; April 15, 1948.

SAN DIEGO

"Radar and Microwaves," by J. O. Perrine, American Telephone and Telegraph Company; March 19, 1948.

SAN FRANCISCO

"Modern Interpretations of the Atom and Universe," by L. Reukema, San Francisco Section Chairman; March 10, 1948.

SEATTLE

"Application of Radio to Railroad Operation," by F. A. Mackenroth, Northern Pacific Railroad, and L. G. Sands, Bendix Radio Company; March 12, 1948.

SYRACUSE

"Selected Patents," by M. D. Norse, General Electric Company; April 1, 1948.

TORONTO

"Electronics in Atomic Energy Research," by N. F. Moody, National Research Council, January 12, 1948.

"Modern Air Navigation Systems," by H. A. Ferris, Trans Canada Airlines; February 2, 1948.

"Trigger Circuits," by J. C. Gray, University of Toronto; February 23, 1948.

"Lateral Disk Recording and Reproduction," by R. E. Penton, University of Toronto; February 23, 1948.

"Volume Expansion," by C. J. Urban, University of Toronto; February 23, 1948.

"Magnetic Tape Recording," by T. E. Lynch, Brush Development Company; March 15, 1948.

TWIN CITIES

"Use and Control of Feedback in A.M. Transmitters," by J. C. Herber, Western Electric Company; March 4, 1948.

WILLIAMSPORT

"Two Signal Performance of Some F.M. Receiver Systems," by B. D. Loughlin, Hazeltine Electronics Corporation; March 31, 1948.

SUB-SECTIONS

AKRON

"Radio Telemetering Airborne Vehicles," by L. L. Rauch, Princeton University; March 25, 1948.

FORT WAYNE

"Electrolytic Capacitors," by J. West, Magnavox Company; March 8, 1948.

(Continued on page 40A)

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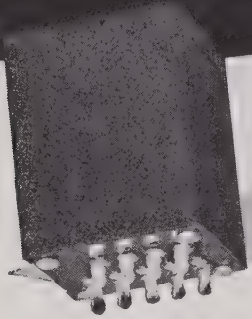

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AUDIO DEVELOPMENT COMPANY

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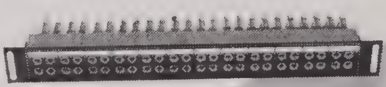

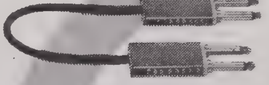

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Jack panels . . . companion to patch cords. Molded plastic for better insulation. Used where quality and durability are needed. Mount on 19″ relay rack. Furnished with jacks assembled or panels only. Write for **ADC** catalog for complete specifications.

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"Audio Develops the Finest"
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SECTION MEETINGS

(Continued from page 38A)

HAMILTON

"Radio Broadcasting in Canada," by O. R. Smith, Radio Station CHML; January 26, 1948.

"Quality Control in Radio Tube Manufacturing," by A. H. Sievert, Canadian Westinghouse Electric Corporation; February 16, 1948.

"Radio Relaying," by C. Bridgland, Canadian Telegraph Company; March 8, 1948.

LONG ISLAND

"Application of High-Speed Electronic Counters," by J. J. Wild, Potter Instrument Company; March 10, 1948.

NORTHERN NEW JERSEY

"The Central Radio Propagation Laboratory Automatic Ionosphere Height Recorder," by C. J. Franks, C. J. Franks Laboratories; February 11, 1948.

Tour of the Federal Telecommunications Laboratories; April 14, 1948.

TOLEDO

"Cathode-Ray Instrument Developments," by S. Sterling, S. Sterling Company; March 29, 1948.

STUDENT BRANCH MEETINGS

ALABAMA POLYTECHNIC INSTITUTE, I.R.E. BRANCH

"The Atomic Age—A New Challenge to Scientists and Engineers," by J. Kuderna, Alabama Polytechnic Institute; March 1, 1948.

UNIVERSITY OF ARKANSAS, I.R.E. BRANCH

"Design Considerations of a Cathode-Ray Oscilloscope," by J. A. Boatwright, Student of University of Arkansas; March 24, 1948.

CASE INSTITUTE OF TECHNOLOGY, I.R.E. BRANCH

"Co-Channel Interference," by R. A. Fox, Radio Station WGAR; March 24, 1948.

UNIVERSITY OF ILLINOIS, I.R.E.—A.I.E.E. BRANCH

"Recent Developments in Automotive Electrical Equipment," by B. H. Short, General Motors Corporation; March 16, 1948.

KANSAS STATE COLLEGE, I.R.E.—A.I.E.E. BRANCH

"Magnetic Recording Illustrates Utilization of Fundamentals," by G. E. Zeigler, Midwest Research Institute; April 1, 1948.

MANHATTAN COLLEGE, I.R.E. BRANCH

"Magnetic Amplifiers," by W. Dornhoefer, Ward Leonard Company; March 11, 1948.

MICHIGAN STATE COLLEGE, I.R.E.—A.I.E.E. BRANCH

"The Engineer in the Field of Management," by S. Dean, Detroit Edison Company; March 3, 1948.

UNIVERSITY OF MICHIGAN, I.R.E.—A.I.E.E. BRANCH

"Design of a High-Fidelity Portable Phonograph Amplifier," by G. R. Leopold, Student; March 24, 1948.

"Developments in Man-Made Radio Interference," by R. C. Walker, Student; March 24, 1948.

STUDENT BRANCH MEETINGS

College of the City of New York, I.R.E. Branch

"Theatre Sound Systems," by R. Siegel, Altec-Lansing Corporation; March 16, 1948.

"The Present Technical Status of Television," by N. Marchand, Columbia University; March 23, 1948.

"Video Techniques," by Professor Millman, College of the City of New York; April 6, 1948.

Northwestern University, I.R.E.—A.I.E.E. Branch

"Choosing a Career in Electrical Engineering," by C. S. Mitchell, Commonwealth Edison Company; February 26, 1948.

Student Paper Competition; March 5, 1948.

Pratt Institute, I.R.E. Branch

"D.C. and A.C. Phase Inverters," by W. J. Heacock, Student; February 24, 1948.

Stanford University, I.R.E.—A.I.E.E. Branch

"Radar and Microwaves," by J. O. Perrine, American Telephone and Telegraph Company; March 29, 1948.

Syracuse University, I.R.E. Branch

"Opportunities for Engineers in the Future," by E. W. Davis, Simples Wire and Cable Company; March 18, 1948.

"Plant Construction and Operation," by B. Green, Oswego Steam Station; April 7, 1948.

The University of Texas, I.R.E.—A.I.E.E. Branch

"Some Experiments in Frictional Electricity," by W. F. Helwig, The University of Texas; March 15, 1948.

University of Utah, I.R.E.—A.I.E.E. Branch

"History and Organization of the A.I.E.E.," by J. A. McDonald, Secretary, local chapter of A.I.E.E.; March 9, 1948.

Worcester Polytechnic Institute, I.R.E.—A.I.E.E. Branch

"Opportunities that are Available for the Young Engineer Today," by E. W. Davis, Simples Wire and Cable Company; March 8, 1948.

"A Simplified Frequency Standard," by W. A. Beers, Student; April 8, 1948.

"Automatic Combustion Control," by F. Holby, Student; April 8, 1948.

"Automatic-Frequency Control for 75 WA Alternator," by O. Kennedy, Student; April 8, 1948.

"Phase Measurements by Pulse Technique," by R. Leaner, Student; April 8, 1948.

"Characteristics of D.C. Motors on Rectified A.C.," by A. Welsey and W. Wagner, Students; April 8, 1948.

"Pulse Detection," by D. Anthony, Student; April 8, 1948.

MEMBERSHIP

The following transfers and admissions were approved on May 4, 1948, to be effective June 1, 1948:

Transfer to Senior Member

Cole, L. S., 696 E. Fourth North St., Logan, Utah
Daugherty, R. M., 14433 Mark Twain Ave., Detroit, Mich.

(Continued on page 44A)

Entirely New! Completely Service-Tested!

RAYTHEON

Voltage Stabilizers

An Outstanding New Line of High Performance, Space and Weight Saving Models that Make It Easy to Build Enduring Accuracy Into Your Product.

The new Raytheon voltage stabilizers enable you to build voltage stability right into your electrical or electronic equipment. They come to you in neat, compact, easy-to-install packages—ruggedly built and performance-engineered for lifetime satisfaction. Choose *your* models from a wide range of standard catalog types . . . or have them custom-engineered to suit your special needs. In either case, count on Raytheon experience and skill to provide the electrical characteristics you want in the most convenient, compact and economical unit.

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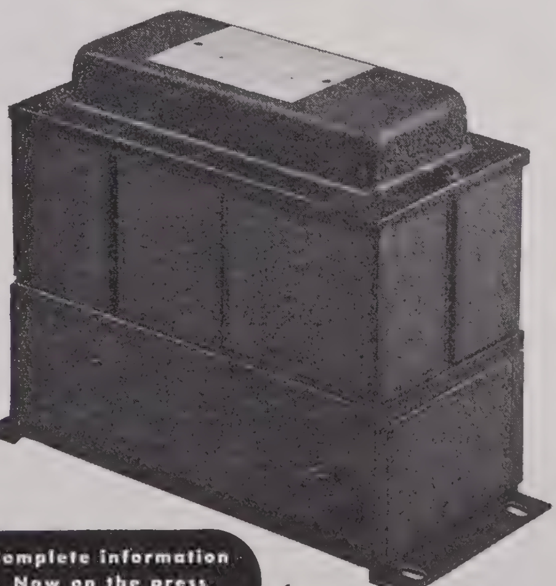
VOLTAGE STABILIZER HEADQUARTERS
Since 1927



Build These Advantages Into Your Equipment

- Control of output voltage to within ±½%.
- Stabilization at any load within rated capacity.
- Many designs with very low harmonic distortion of the output voltage wave *at any load.*
- Quick response. Stabilizes varying input voltage within 1/20 second.
- Entirely automatic. No adjustments. No moving parts. No maintenance.
- Wide range of designs including hermetically sealed types.

Complete information Now on the press

A new bulletin covering applications, performance features, operating characteristics, graphs, specifications, etc., for the entire new line of Raytheon Voltage Stabilizers.

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Gentlemen: Please send me copy of your new Voltage Stabilizer Bulletin DL-V-304-F

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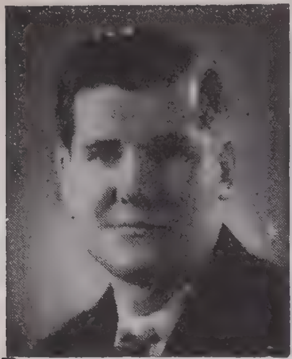
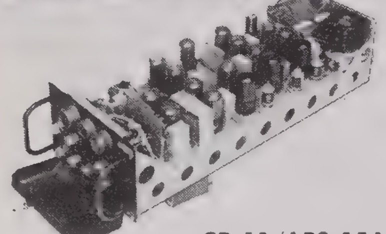
City__________ State__________



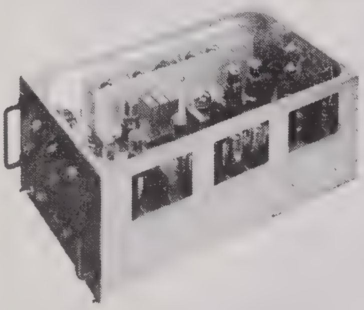
ESSE Specials!

Do not fail to closely examine this list of war surplus bargains. We believe that every item listed below is a sensational value that soon can never be repeated. All equipment advertised herein is unconditionally guaranteed to the customer's satisfaction to this extent: Return any item advertised within five days after delivery for full refund except transportation charges (both ways).



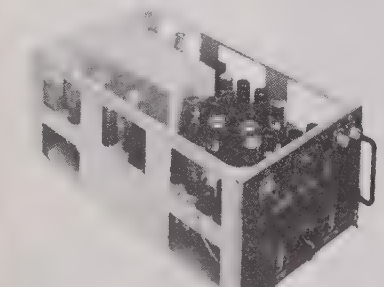
CP-11/APS-15A

Parts and tubes galore—a total of 17 tubes included, consisting of 13—6SN7GT's, 3—6SA7GT's and 1—5Y3GT. Other useful parts such as 24 V. DC motor and blower (operates on 110 V. AC), precision wire-wound 1 Meg. resistors, 80.86 Kc. crystal (1 mi. wavelength), pots, condensers, relays, etc. too numerous to mention. Weights 21 lbs. Size 22″L x 8″W x 5″H. ....**Price $9.95**



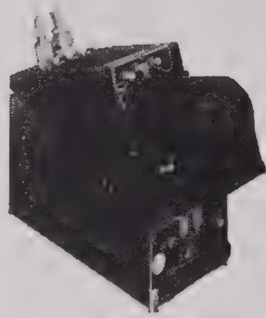
BC-1155-A SYNCHRONIZER

Another invaluable unit for the Television and VHF experimenter. Contains 19 Mc. IF strip using 5—WE717A tubes. A total of 24 tubes included, consisting of 6—WE-717A's, 2—6SL7GT's, 2—6AC7's, 5—6SN7GT's, 2—6N7GT's, 2—6L6's, 1—6V6GT, 2—6AG7's, 1—6AC7, and 1—6H6GT. Other parts included are 6 pots, 10 Amphenol 831R chassis connectors and numerous condensers, resistors, and transformers. Weight 22 lbs. Size 21″L x 11½″W x 7¾″H. ....**Price $17.75**



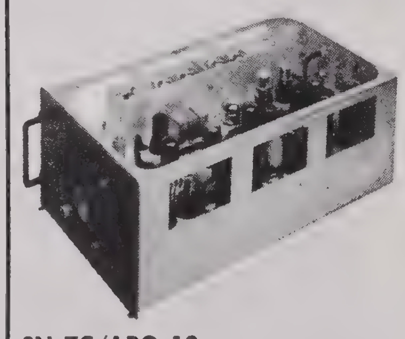
SN8/APQ-5B

Contains 31 useable tubes consisting of 2—6H6's, 3—6AC7's, 2—2050's 1—6SA7GT, 2—VR105's, 10—6AG7's, 7—6SN7GT's, 1—VR75, 2—6SL7GT's, 1—6N7. Other parts such as 17 Shallcross precision wire-wound resistors of 30,000, 120,000, 150,000, 250,000, 20,000, 200,000 and 100,000 ohms value. Relay DPDT, variable condensers, Amphenol and Cannon connectors, tap switches, networks and transformers make this another invaluable parts item at the advertised low price. Weight 28 lbs. Contained in aluminum case 17½″L x 11⅛″W x 7½″H. ....**Price $14.95**



ID-57/APQ-7 RADAR SCOPE

Contains 12 tubes: 1—5FP7, 3—6L6G's, 1—6AG7, 2—6SL7GT's, 2—6AC7's, 2—6SN7GT's, 1—6H6GT. 2 WE D168479 tube type K80 relays, magnetic yoke, pots, precision resistors, condensers, toggle switches, etc. Weight 26 lbs. Size 14″H x 20½″L x 8″W.
Price $14.95



SN-7C/APQ-13

Sensational offer for Television engineers. Contains 19 Mc. IF strip containing 5—WE717A tubes. Other HF strips containing 2—6AK5's, 3—6SL7GT's, 1—WE717A, 4—6SN7GT's, 2—6N7's, 2—6L6's, 1—6H6, 3—6AC7, 2—6AG7, 1—6V6. A total of 26 tubes. Other parts such as DPDT relay, 7 pots, 12 Amphenol 831R chassis connectors, and numerous condensers, toggle switches, RF chokes, variable condensers, and transformers. Weight approx. 25 lbs. Size 20″L x 11½″W x 7¾″H. ....**Price $19.50**

PEC-181 RECTIFIER

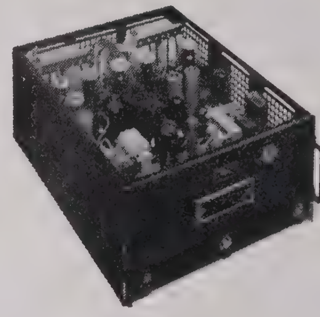
Input: 105-125 V. or 210-250 V. 50-60 cycle AC. Output: 7 amps. continuous at 120 V. DC. The output is effectively controlled over a range of 110-135 volts. By means of a screw-driver slot control. the rectifier may be adjusted to maintain any voltage within above range. Size 32.5″H x 20.5″W x 14.5″D. Weight 265 lbs. $79.50

ARGON INCANDESCENT LAMP

2 watt pear shape with regular AC type screw base. New. **Sold $.35 each carton of ten only**

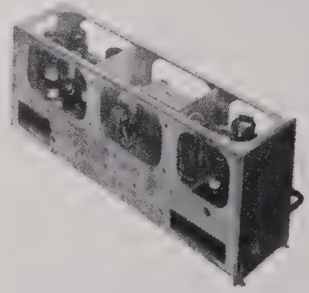
WESTINGHOUSE MERCURY-VAPOR

Battery charger bulbs. Commercial 6A. Style 289416, for screw socket. For 6 or 7 batteries charged at one time—2000 to 3000 hours with special high resisting glass. New. $3.95



PP-72/APQ-7

Contains 20 tubes: 6—5R4GY's, 1—6L6GT, 6—6Y6G's, 3—6SL7GT's, 2—VR105's, 2—VR150's, 1—24 V. blower and motor (may be operated on 110 V. AC 60 cycles). Numerous power resistors, HV transformers, condensers, jacks, cannon connectors, etc. Weight approx. 40 lbs. Size 25″L x 15½″W x 7¾″H, in metal case. ....**Price $19.75**



PP-2/APQ-5 POWER UNIT

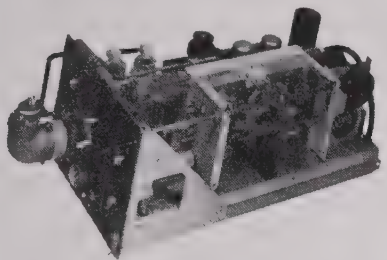
400 cycle, 115 V. Contains 10 tubes as follows: 2—5U4G's, 1—6X5GT, 4—6Y6G's, 1—6SL7GT's, 2—VR150-30 and numerous condensers, transformers and resistors. Weight 17 lbs. Size 21″L x 5½″W x 7¾″H.
Price $5.75

INDICATOR SCOPE ID-41/APQ-13

About 6″ diameter by 15″ deep. Contains 1—5FP7, 1—6AK5 tube, 5 Grain of Wheat 3 V. pilot lights, magnetic deflection yoke, condensers, potentiometers, sockets.
Price $6.95

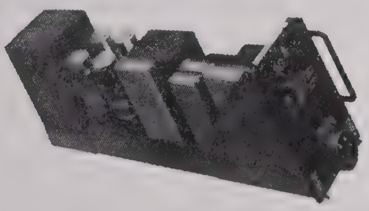
T-26/APT-2 RADAR TRANSMITTER

Contains tunable VHF curcuit using 2—JAN CTL 703A's or 368AS tubes. Other tubes are: 2—5R4GY's, 1—2X2, 1—807, 1—6AG7, 2—6AC7's, and 1—931A. Other parts such as 24 V. DC motor and blower, HV. condensers and transformers, terminal strips and Amphenol connectors, knobs, fuse holders, etc. make this unit invaluable for parts alone. Weight approx. 45 lbs. Size 21"L x 10½"W x 7¾"H, in metal case.
Price $9.75



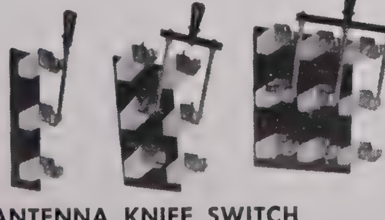
T-39/APQ-9 RADAR TRANSMITTER

Loaded with VHF parts and tubes such as 2—RCA 8012's, 1—931A, 2—807's, 1—6AG7, 2—6AC7's. The RCA 8012's are rated at 50 W. input to 500 Mc. Contains variable parallel-plate oscillator silver plated, ventilating blower and motor, ceramic tap switch, pots, terminal strips, gears, counters, etc. Weight 36 lbs. Size 22"L x 10½"W x 7¾"H.
Price $9.75



PP-51/APQ-9 RECTIFIER POWER UNIT

400 cycle 115 V. Contains 4—5R4GY, 2—4Mfd. 1000 V. DC condensers, 2—1 Mfd. 1500 V. DC condensers, 400-2600 cycle transformers, power resistors, etc. Weight 38 lbs. Size 21"L x 5⅛"W x 7¾"H. ....**Price $4.95**



ANTENNA KNIFE SWITCH

Has 2½" porcelain insulator bakelite base, heavy blades 4" long.

Single Pole Double Throw	$ .75
Double Pole Double Throw	1.00
Triple Pole Double Throw	1.25

CUTLER-HAMMER SWITCH ASSEMBLY

Consists of four DPST bat-handle toggle switches, each rated at 20 amps 125 volts, with connecting straps. Price per assembly of four $1.00

HEAVY DUTY TOGGLE SWITCH

CH type C-5A DPST 20 A. 125 V. $.35

HEAVY DUTY TOGGLE SWITCH

CH type AN-3023-10 DPDT Momentary Contact 30 A. 125 V. $.35

HEAVY DUTY TOGGLE SWITCH

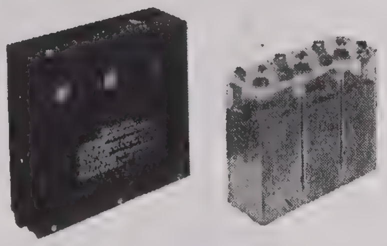
CH type C-2 DPST Center off 30 A. 125 V. $.50

HEAVY DUTY TOGGLE SWITCH

AN-3022-6B SPDT Center off 30 A. 125 V. $.25

HEAVY DUTY TOGGLE SWITCH

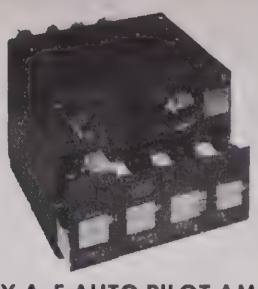
CH type AN3027-2B DPST 20 A. 125 V. $.25



6 V. (New) (Dry-charged)	**$3.00**
6 V. (In metal carrying case) (Add electrolyte specific gravity 1.265) (Drugstore)	**$4.00**

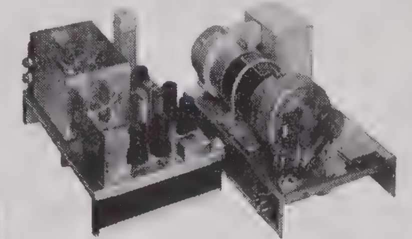
DYNAMIC HANDMIKE

High impedance type—with press-to-talk switch that shorts microphone when released and operates a relay or other circuit when depressed. Designed for close talking PA and mobile communications service. Speech is brisk and clear. Made to stand rough handling. Black wrinkle finished. Has 6 ft. 3 conductor shielded rubber covered cable and standard amphenol plug. Made by Electro-Voice for the Signal Corps. Comparable mikes list at $28.00. Special, each $7.95



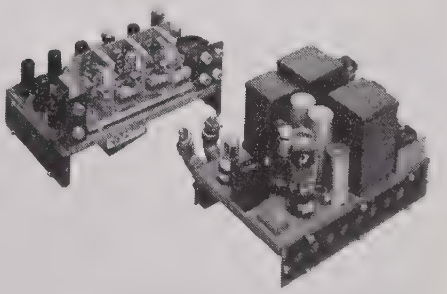
SPERRY A-5 AUTO PILOT AMPLIFER RACK

Contains 115 V. AC voltmeter and 350-450 cycle Frequency meter. A total of 4 amplifier chassis complete with following tubes included in rack: 2—1631's, 6—1632's, 3—1633's, 3—1634's, and 2—1644 tubes. Numerous transformers, resistors and condensers make this unit invaluable for parts. Weight 38 lbs. Size 12"L x 14"W x 10½"H. ....**Price $6.95**



TYPE CRZ-43AA AIRCRAFT RADIO RECEIVER

Another item for the VHF experimenter. Contains ten tubes: 6—SH7's, 2—6H6's, and 2—7193's. Relays, condensers, resistors, Amphenol connectors, dynamotor, carbon pile voltage regulator and numerous other parts. Weight approx. 32 lbs. Size, 12"W x 11"H x 8"D. **$6.95**



BC-800A RADAR TRANSMITTER & RECEIVER

Loaded with tubes and components for the VHF experimenter. Contains 19 tubes including 1—955, 3—956's, 1—2C26, 1—5U4G, 1—2X2, 1—6SN7, 7—6AC7's, 2—6SL7GT's, 1—6V6GT, and 1—6H6GT/G. Several HF tuned circuits, 7 amphenol chassis fittings, sockets, 24 V. blower and motor (will operate on 110 V. AC), 2—4Mfd. 600 V. condensers, and many other resistors and parts. Weight approx. 40 lbs. In metal case 12½"W x 11½"H x 8"D. **$14.95**

32 FT. MAST

And complete antenna kit. Four round wooden poles (1½" dia.) each 8 ft. long; when fitted together makes a 32 ft. mast. Can be erected to a height of 8, 16, 24 or 32 ft. Complete with guy ropes, hardware, 100 ft. PB antenna wire, 80 ft. PB ground wire, hand reel and heavy Army canvas carrying bag—suitable for use as sleeping bag. An excellent kit for field use. FM or TV antenna supports, flag, poles, etc. Our low price complete, only **$18.95**

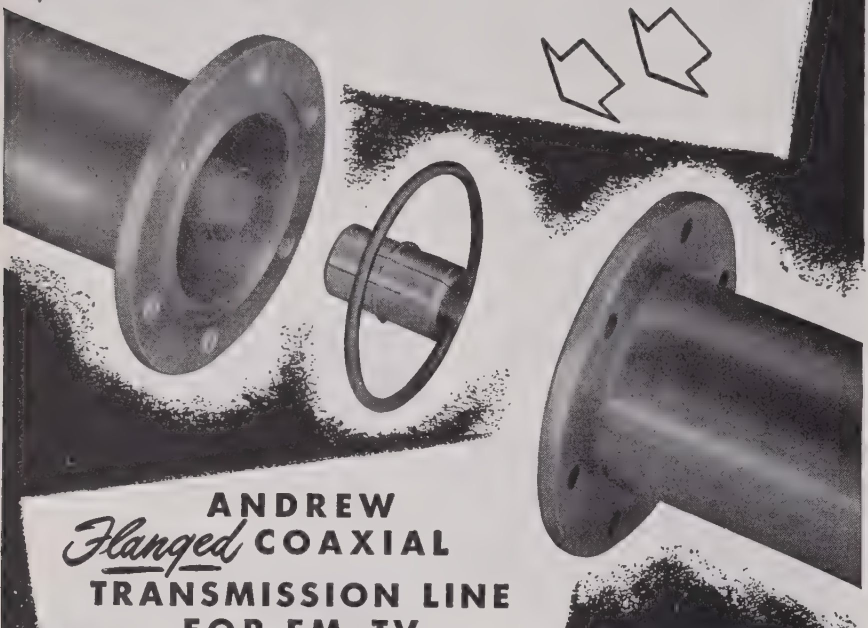
ESSE Radio Co

130 W. New York St.
Indianapolis 4, Ind.

Unless Otherwise Stated, All of This Equipment Is Sold As Used
CASH REQUIRED WITH ALL ORDERS
Orders Shipped F.O.B. Collect

Simple New *Solderless* Couplings

Maintain Constant 51.5 Ohm Impedance



ANDREW
Flanged COAXIAL
TRANSMISSION LINE
FOR FM-TV

Offering the dual advantage of easy, solderless assembly and a constant impedance of 51.5 ohms, this new ANDREW FM-TV line is available in four diameters. Each line fully meets official RMA standards. It also is recommended for AM installations of 5 Kw or over.

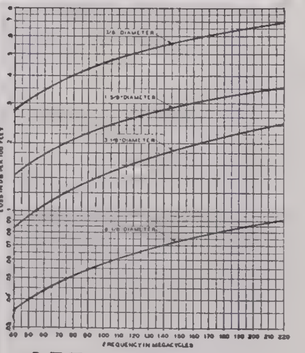
Fabricated in twenty foot lengths with brass connector flanges silver brazed to the ends, sections are easily bolted together. A circular synthetic rubber "O" gasket effectively seals the line. Flux corrosion and pressure leaks are avoided. A bullet-shaped device positively connects inner conductors.

Close tolerances are maintained on characteristic impedance in both line and fittings, assuring an essentially "flat" transmission line system.

Mechanically and electrically better than previous types, this new line has steatite insulators of exceptionally low loss factor. Both inner and outer conductors of all four sizes are of copper having very high conductivity.

Flanged 45 and 90 degree elbow sections, and a complete line of accessories and fittings available.

Better be safe, than sorry. Avoid costly post-installation line changes. Get complete technical data, and engineering advice, from ANDREW now.



ATTENUATION CURVE

shows total loss plus 10% derating factor to allow for resistance of joints and deterioration with time.

Four diameters available: 6⅛"—3⅛"—1⅝" and ⅞".

Andrew
CORPORATION
363 EAST 75th STREET · CHICAGO 19

Pioneer Specialists in the Manufacture of a Complete Line of Antenna Equipment

MEMBERSHIP

(Continued from page 41A)

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Fund, S. R., 9224 Longbranch Pkwy., Silver Spring, Md.
Gould, R. V., 56 Goodrich St., Hempstead, L. I., N. Y.
Jackson, J. E., RCA Victor Company, Ltd., 1001 Lenoir St., Montreal 30, Que., Canada
Jackson, T. H., Jr., 4233 W. 61 St., Los Angeles, Calif.
Kline, M. B., 267 Santiago Ave., Rutherford, N. J.
Lafferty, J. M., General Electric Research Laboratory, Schenectady, N. Y.
Lappin, L. S., 4227 Terrace Ave., Merchantville, N. J.
Medd, J. S., Box 342, Chrsitian Ave., Stony Brook, N. Y.
Nelson, J. E., Tube Division, General Electric Company, Schenectady 5, N. Y.
Page, C. H., 11312 Old Bladensburg Rd., Silver Spring, Md.
Paschon, H. E., 726 W. Maple Ave., Merchantville, N. J.
Pierson, C. D., Jr., 1338 N. Laramie Ave., Chicago, Ill.
Potter, E. H., 213 Morgan Ave., Collingswood, N. J.
Pratt, J. H., RCA Victor Company, Ltd., 1001 Lenoir St., Montreal, Que., Canada
Randall, D. P., Box 28, University Station, Syracuse 10, N. Y.
Smith, S. R., 202 E. 52 St., Savannah, Ga.
Stearns, H. M., 319 Northern Pkwy., E. Hempstead, L. I., N. Y.
Stevens, C. A., 71 Wyman St., West Medford 55, Mass.
Stone, F. B., 330 Beechwood Ave., Haddonfield, N. J.
Terrell, J. A., 320 Belmont Ave., Haddonfield, N. J.
Turner, C. G., 106 W. 14 St., Kansas City 6, Mo.
Washburn, E. M., 6748 Rogers Ave., Merchantville, N. J.
Webber, F. G., 9 Federal Ct., Springfield 5, Mass.
Wiesner, J. B., 25 Bellevue Rd., Belmont, Mass.
Wilner, J. T., 74 Dayton St., Elizabeth 2, N. J.
Yanagisawa, S. T., Machlett Laboratories, Inc., Springdale, Conn.
Young, K. A., 43 Dwhinda Rd., Waban 68, Mass.

Admission to Senior Member

Blauvelt, R. C., 510 Elmwood Rd., Bay Village, Ohio
Cooper, W. H., Box 9, R.F.D. 1, Long Branch, N. J.
D'Albora, J. B., Jr., 84 Maple Ave., Morristown, N. J.
Duke, V. J., 32 Fountain Ave., Rockville Centre, N. Y.
Glentzer, K. V., 208 W. Washington St., Chicago, Ill.
Perkins, J. R., E. I. du Pont de Nemours, 626 Schuyler Ave., Arlington, N. J.
Philpott, L. R., Finch Telecommunications, Inc., Fourth and Virginia Sts., Passaic, N. J.
Rackey, C. A., 150 Chittenden Ave., Crestwood, N. Y.
Steward, W. B., Box 2175, Houston 1, Tex.

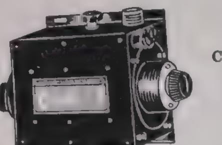
Transfer to Member Grade

Austin, R. W., 1262 Lowell Rd., Schenectady 8, N. Y.
Bawden, H. G., Chatham Courts, Apt. 45. Chatham, N. J.
Blanchard, H. P., Electrical Engineering Department, Stanford University, Calif.
Buff, C., R.F.D. 2, Babylon, N. Y.
Desikachar, P. R., 85 Livingstone St., Brooklyn 2, N. Y.
Fitzallen, J. H., 68 Brentcliffe Rd., Toronto, Leaside, Ont., Canada

(Continued on page 46A)

POWER EQUIPMENT "Communications" RADAR—AIRCRAFT AMATEUR—INDUSTRIAL

MICROWAVE SPECIALS



CP 14/APS-15A Altitude Computer. Controls: sweep phasing, range altitude. Compiles slantrange – ground range against altitude	$15.50
"X" BAND AN/APS-15A: Complete RF head & modulator, including: 725-A magnetron & magnet, 2-723/AB klystrons, local oscillator & beacon, 1B24 TR, receiver amplifier, duplexer unit, HV Pwr. supply, blower, pulse transformer. Pk. Pwr. out 45 KW (approx.) Input: 115 v, 400 cy, 3 amps. Modulation pulse duration .5 to 2 microsec. approx. 13 KV PK pulse. Complete with all tubes, including 715B, 829B, RKR 73, and 2-'72's. Complete Package, new	$210.00
"X" BAND APS-15B RF HEAD. Complete, including 725-A magnetron and magnet, 2-723/AB klystrons (local oscillator and beacon), 1B24 TR, receiver amplifier, duplexer unit, HV Pwr. Supply, blower, pulse transformer. PK. PWR out: 45 KW (approx.). Input: 115 v, 400 cy, 3 amps. Complete package, new	$150.00
BC 701-A Radar Receiver, Part of SCR 521 and ASE eqpt. 176 mc operation, receives bi-lobed search and homing patterns. Complete with tubes and antenna switching motor.	$37.00
BC 704-A Scope, part of SCR 521 and ASE equipment. "L" scope with linear range sweep upward from bottom. Suitable for search, homing, on beacon or target. With all tubes, including 5BP1.	$17.50
Yagi Antenna Switching Motor for ASE and SCR 521 sets. Operates on 24 v.d.c, at 1800 RPM, DPDT.	$2.00
Sra Radar Tranceiver Console. Freq. range: 450 to 750 mc. Monitor scope, monitor receiver, 115 vac power supply	$600.00

10 CM PLUMBING

Pounder Mixer Cavity, 10 CM	$4.50
721-A TR cavity with tube. Complete with tuning plungers.	$5.50
Line Stretcher complete with remote control cable in standard guide with square flanges	$50.00
Waveguide section, MC 445A, rt. angle bend, 5½ ft. OA, 8" slotted section.	$25.00

RIGID COAXIAL LINE

⅞", ⅜" IC Slotted section. 10" long	$5.50
Flexible section, ⅞", ⅜" IC connectors 15" L. Male to female. Pressurized	$3.25
⅞", ¼" IC, TYPE 4½' flexible section CG 54/U.	$4.75
⅝" Quarter wave tuning stub, 8" stubs.	$4.50
⅝" Slotted section, 10" L.	$3.75
Type "N" Dual Female output section, for flex coax line	$2.75

3CM. PLUMBING

2½" Flexible section, cover to cover	$4.00
Short Arm "T" section, with additional choke output on vertical section.	$4.00
Cutler feed dipole for use with parabola, 12½" L.	$5.50
90 Deg. twists, 5" L. choke to cover, with press. nipple	$5.00
2K25/723AB X band local oscillator mount with: choke coupling to beacon reference cavity; choke coupling to TR and receiver; Iris coupling with AFC attenuator to antenna waveguide RUN Radar AFC crystal mount; Receiver crystal mount; Attenuating slugs. Mfg. DeMornay Budd.	$22.50
TR/ATR Duplexer section for above.	$4.00

TEST EQUIPMENT

3 cm. Wavemeter. Micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,000 Mc.	$75.00
Direct reading VSWR meter. Complete with amplifier, bolometer input-AC crystal connections	$45.00

MISCELLANEOUS

Magnet ring, made of Alnico V, 3½" o.d, 2½" i.d, X 1-¾" thick. Wt. 2¼ Lbs.	$2.00
Leather viewing hoods for 5" Oscilloscope	$1.85

CONNECTORS

UG 254/U	$.75
UG 255/U, Adapts UG 254/U to Amphenol low loss series	$.85

COAX CABLE

RG 18/U, Armored, 52 ohm imp. Per ft.	$.51
RG 24/U, Twin Coax, 125 ohm imp. Armored, Per ft.	$.51
RG 28/U, 48 ohm imp. Per ft.	$.51

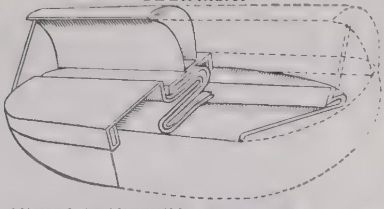
KLYSTRON TUBES

2K25-723/AB	$7.75
707 B.	$20.00

CATHODE RAY TUBES

12GP7	$10.95
3Eppl.	$2.95
3Dpl.	$2.55
3GPl.	$3.55

MICROWAVE ANTENNA EQUIPMENT



AN/MPG-1 ANTENNA. Rotary feed type high speed scanner antenna assembly, including horn, parabolic reflector, as illustrated. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused	$250.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism	$65.00
AS 69/APT, Transmitter Jamming antenna, consists of 4 radiators, polarized for hor. and vert. radiation. Type "N" input	$18.50

DYNAMOTORS

PE 73 CM (G.E.) Power supply for BC 375 Input: 28 VDC Output: 1000 VDC @ 350 Ma. New	$4.95
BD 77KM Power Supply for BC 191 with spare fuse links, etc. Input 14 v.d.c. Output 1000 v. @ 350 ma. New	$9.95
Used excellent condition	$5.95
PE 101-C input 13/26 VDC @ 12.6/6.3 A. Output 400 VDC @ 135 Ma., 800 VDC @ 20 Ma. VAC @ 1.12 A. new	$3.49
PE 86 N. Imput: 28 VDC, Output: 250 VDC @ 60 ma.	$1.95
DAG 33A Input: 18 VDC @ 3.2 A. Output: 450 VDC @ 60 Ma.	$2.45
DM 33: Input 28 VDC @ 7 a. Output: 540 VDC @ 250 Ma. Power supply for SCR 274 modulator	$3.95
DM 23350: Input 27VDC @ 1.75 A. Output: 285 VDC @ 75 Ma.	$3.50
DM 21: Input: 14 VDC. Output 235 VDC @ 90 Ma. Power supply for BC 312	$2.49
PE 55, Input: 12 vdc @ 25 amp. Output 500 vdc @ 400 ma. (slightly used)	$4.95
MP 10 G Power supply, using 2 dynamotors. Input: 24-28 vdc. Output: 1000 vdc @ 400 ma. 230 vdc @ 100 ma. New complete with relays, filters, etc. BENDIX	$40.00
B-19 power pack (dynamotor). Input: 12 vdc @ 9.4 amp. Output: 275 vdc @ 110 ma. 500 vdc. @ 50 ma. New, complete in metal case with 2 plugs, filters, etc.	$6.95
DM 28-R. Input: 28 v.d.c. @ 1.25 amp. Output: 270 v.d.c. @ 70 ma. New, with enclosed terminal box.	$3.25
ZA/USA .0515, Input: 12/24 v.d.c. 4/2 amp. Output: 500 v.d.c. @ 50 ma. Compact square shape, size: 7½"x4¼"x3"	$3.95
ZA/USA .0516, Input: 12/24 v.d.c. @ 8/. amp. Output: 275 v.d.c. @ 110 ma., 12 v.d.c. @ 8 amp. Compact square, size 7½"x4¼"x3"	$4.25
DM-25: In 12VDC 2.3A Out 250DVC 50 ma.	$2.49
DM-42: In 14VDC. Out 515/1030 VDC 215/260 ma. and 2/8VDC	$3.95
BD-AR 93. Input: 28vdc @ 3.25 amp. Output: 375 vdc @ 150 ma. Pioneer, New	$4.95

INVERTERS

PE 206-A. Input: 28 v.d.c. @ 38 Amp. Output: 80 volts @ 500 volt-amp, 800 cy. Leland Electric. New, complete with instruction book, relays, filters, etc.	$12.50
PE 218—Input: 25-28 v.d.c. @ 92 amp. Output: 115 volts, 1500 volt-amps, 380/500 cy. Leland Electric. Used, good condition	$20.00

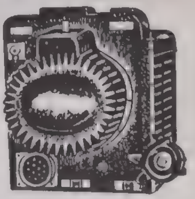
RELAYS

BO 6D35, DPDT, 18-28 vdc. contacts 10 amps @ 115 vac	$1.25
7220-24, Contactor, SPST, 24-28 vdc. contacts 400 amps	$1.20
1077BF, Antenna changeover, DPDT, 28 vdc.	$1.15

TELEPHONE RELAYS

GR 206, DPST, 500 ohms, 24 vdc (Normally open)	$1.05
SC 5853 A. SPST w/spdt section, 24 vdc, 1000 ohms	$1.10
Kurman latching relay #X-1400, 110 vac, 60 cy.	$1.45

PULSE EQUIPMENT



APQ-13 Pulse modulator. Pulse width, .5 to 1.1 micro sec, repetition rate 624 to 1348 PPS, pk pwr. out 35 KW. Energy 0.018 Joules.	$49.00
Pulse transformer for 725-A magnetron.	$12.65
715-B with socket	$8.50
Pulse Xfmr. KS 9948, Imp ratio 700 to 50 ohms, 18 KVDC, unpotted, uncased.	$6.50
Line insertion attenuator, type OAX-1. 20 Db. attenuation, with 3-contact plug and socket (Amphenol 16S-5)	$2.25
Delay Line, 5.0 micro sec max, 500 ohms impedance, 12 taps.	$4.00
Trihedral Radar Reflector, MK 1.	$4.00
Lighthouse Cavity for GL 446. Cavity dim: 3-¾" × 2¼" diam.	$5.50

POWER EQUIPMENT

STEP DOWN TRANSFORMER: American Pri: 440/220/110 volts a.c. 60 cycles, 3 KVA. Sec. 115 v., 2500 volt insulation, size: 12" x 12" x 7"	$40.00
PLATE TRANSFORMER, Amertran Pri: 117 v. @ 144 ma. with choke. Oil immersed. Size 26" x 29" x 13"	$65.00
PLATE TRANSFORMER. American Pri: 220 v. 60 cy, 3 phase, 30 KVA. Sec: 6150, 5620, 5050, 4500 volts. Oil filled, 89 gal., with thermostat. Size: 54" x 32" x 23". Wt. APX 1500 lbs.	$250.00
Plate Transformer: Pri: 115/230 v.a.c, 50-60 cy. sec: 21,000 v, 100 ma.	$145.00
Plate Transformer: Pri: 115 v.a.c., 400 cy. Sec: 9800 or 8600 v. @ 32 ma. dc.	$12.50

VOLTAGE REGULATORS

LINE VOLTAGE REG 2 KW Saturable reactor type Pri 95-130 v 60 cy Sec 115 v 60 cy. 17.4 A 2 KW 100% P.F. Raytheon	$160.00
LINE VOLTAGE REG Pri 92-138v 57/63 cy. 1ph 15 A Sec 115v 7.15A. 82 96% PF. Raytheon	$135.00

Self-Contained Unit in Grey Cabinet.

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.25 mf @ 20000 VDC Aerovox	$17.50
1.5 mf @ 6000 VDC Aerovox	$12.50
.1 mfd @ 10,000 KVDC, GEPYR #14F191	$15.00
.0016 mfd @ 15 KVDC, GEPRY #26F700	$8.45
.015 mfd @ 16 KVDC, GEPYR #25F835	$7.50
.005-.005-.01 mfd @ 10 KVDC, GEPYR #26F344	$6.95
.06 mfd @ 15 KVDC, GEPYR 25F585-G2	$8.70
2X.1 mfd @ 7,000 vdc, GEPYR 25F774	$3.95

MICA

.08 mf @ 1500 VDC, Sprague MX60	$11.50
.03mf @ 2000 VDC, CD 551A-50	$12.75
.045 mf @ 2000 VDC, Sangamo, G1	$12.75
.00015 mf @ 20KV Aerovox 1970-404	$25.00
.0001 mf @ 20 KV, Sangamo G3	$25.00

CERAMICON CAPACITORS

(Erie, Centralab) $7.50 per 100

8 mmf	±5%	67 mmf	±20%
5 mmf	±5%	100 mmf	±5%
4 mmf	±.5 mmf	115 mmf	±2%
8.5 mmf	±.5 mmf	120 mmf	±5%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	—
48 mmf	±2%	500 mmf	+15—30%
50 mmf	±20%	1000 mmf	±5%
60 mmf	±3%		

SILVER-MICA BUTTON CAPACITORS

(Erie, Centralab) $9.50 per 100

185 mmf	±2.5mmf
175 mmf	±2.5mmf
500 mmf	±10%

PRECISION COMPONENTS

Precision condenser: W.E. #D-166602, 16 mfd @ 400 vdc, temp comp-50 to 85 deg C.	$7.50
Precision condenser: W.E. D-161270, 1 mfd @ 200 vdc, temp comp -40 to plus 65 deg. C.	$5.00
Precision Resistor: W.E. D-171221, matched pair, 6.330 meg.	$2.50

400-2400 CYCLE TRANSFORMERS

#13345T-3, Fil Xfmr: Pri: 115 v, 400 cy. Sec: 1150-0-1150 v, 40 ma. GE 68G631	$1.75
#12033, Plate Xfmr: Pri: 115 v, 800 cy. Sec: 4540 vct, 250 ma.	$4.50
#12139, Fil. Xfmr: Pri: 115 v, 800-2400 cy. Sec: 5 v, 3 amp, 6.3 v, 2 amp.	$1.75
KS 9445, Pwr. Xfmr. Pri: 115 v, 400-2400 cy. Sec. 592 vct, 120 ma; 6.3 v, 8 amp; 5 v, 2 amp.	$3.50
Plate Xfmr: Pri: 115 v, 400-2400 cy, Sec: 4500 v, 6 ma.	$6.50
#7143, Pri: 115 v, 400 cy. Sec: 6.3 v, 7 amp, 6.3 v, 8.8 amp, 6.3 v, 1.3 amp.	$2.50
Plate Xfmr. Pri: 115 v, 400 cy .012 KVA. SEC: 600 vct, .036 amp GE 70G30G1.	$1.15
Fil. Xfmr. Pri: 115 v, 400 cy. Sec: 6.3 v, 9 amps; 6.3 vct. .65 amp; 2.5 v. 3.5 amp; 2.5 v. 3.5 amp.	$3.25

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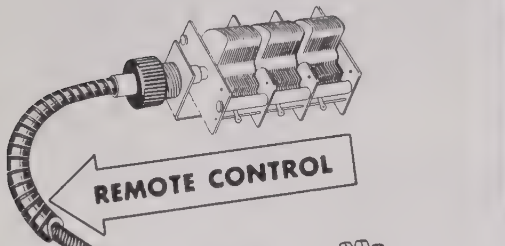

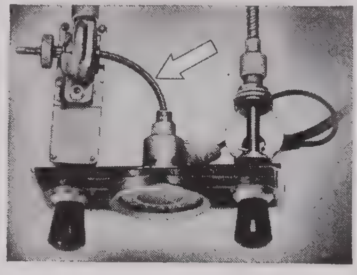
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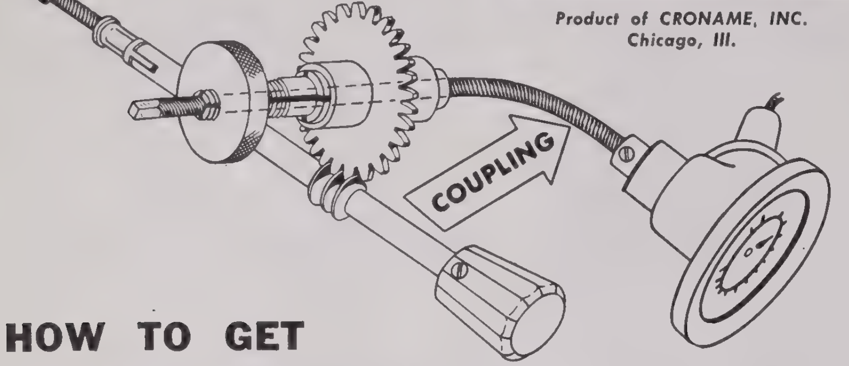

HOW TO GET
"DUAL CONTROL" FROM ONE KNOB

The illustrations above show the ingenious way in which this was done on an automobile radio with S.S.White flexible shafts.

Note the method used to connect the coupling shaft to the worm gearing on the remote control shaft. It passes through the worm wheel hub and is clamped by a split collet on the end of the hub as shown in the sketch. This permits a nice adjustment of the coupling shaft length to give smooth, free operation.

You may find this idea useful in your design work. If you want to know more about it—and about many other design-simplifying uses of flexible shafts—

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This 260-page book gives facts and full engineering data about flexible shafts and how to select and apply them. A copy sent free, if you write for it on your business letterhead and mention your position.

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(Continued on page 48A)

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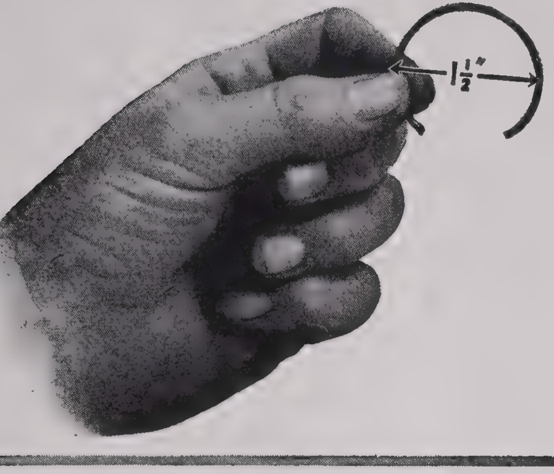

CONVENTIONAL POTENTIOMETERS have a coil diameter of approximately 1½" and provide only 4" (about 300°) of potentiometer slide wire control.

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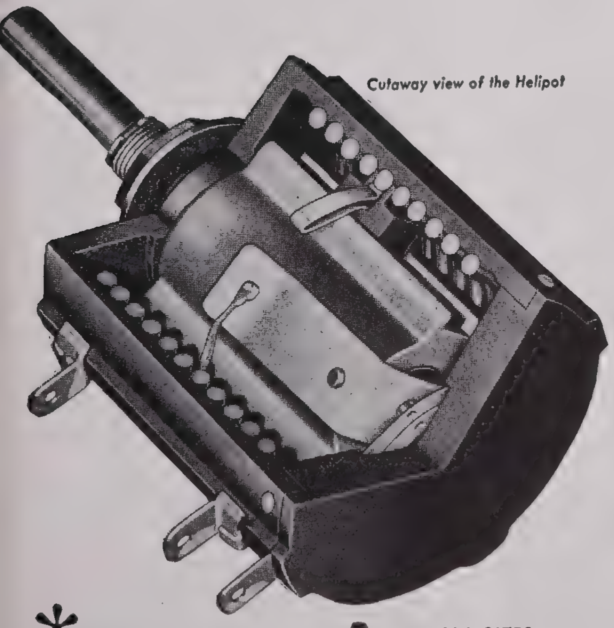

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Some of the multiple **Helipot** advantages

EXTENSIVELY used on precision electronic equipment during the war, the Helipot is now being widely adopted by manufacturers of quality electronic equipment to increase the accuracy, convenience and utility of their instruments. The Helipot permits much finer adjustment of circuits and greater accuracy in resistance control. It permits simplifying controls and eliminating extra knobs. Its low-torque characteristics (only one inch-ounce starting torque*, running torque even less) make the Helipot ideal for power-driven operations, Servo mechanisms, etc.

And one of the most important Helipot advantages is its unusually accurate linearity. The Helipot tolerance for deviations from true linearity is normally held to within ± 0.5%, while precision units are available with tolerances held to 0.1%, .05%, and even less—an accuracy heretofore obtainable only in costly and delicate laboratory apparatus.

The Helipot is available in a wide range of types and resistances to meet the requirements of many applications, and its versatile design permits ready adaptation of a variety of special features, as may be called for in meeting new problems of resistance control. Let us study your potentiometer-rheostat problem and make recommendations on the application of Helipot advantages to *your* equipment. No obligation of course. Write today.

*HELIPOTS ARE AVAILABLE IN 3 STANDARD SIZES:

TYPE A—5 watts, incorporating 10 helical turns and a slide wire length of 46 inches, case diameter 1¾", is available with resistance values from 25 ohms to 30,000 ohms.

TYPE B—10 watts, with 15 helical turns and 140" slide wire, case diameter 3¼", is available with resistance values from 100 ohms to 100,000 ohms.

TYPE C—2 watts, with 3 helical turns and 13½" slide wire, case diameter 1¾", available in resistances from 5 ohms to 10,000 ohms.

The Type B is also available in special sizes of 25 and 40 helical turns, with resistances ranging from 500 ohms to 300,000 ohms, and containing more than 100,000 change-of-resistance steps.

*Data above is for the standard Type A unit.

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MODEL MI-1, Standard Housing

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Model EA-2 Equalizer-Amplifier, self-powered, provides adjustable "bass-boost" with adjustable treble "roll-off" and selection of "turnover frequency."

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Wesley, F. D., Prairie View, Tex.
Wever, L. R., Department of Electrical Engineering, University of South Cqrolina, Columbia, S. C.

The following admissions to Associate were approved on May 4, 1948, to be effective as of June 1, 1948:

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Arnesen, R. F., 62 Clark St., Brooklyn 2, N. Y.
Ball, M. T., 74 Niagara St., Buffalo 2, N. Y.
Becker, J. G., R.F.D. 3, Kitchener, Ont., Canada
Bers, G. M., 1352 Sheridan St., N.W., Washington, D. C.
Bertola, J., Brown Boveri, Cia Sudamericana de Electricidad, San Martin 379, Buenos Aires, Argentina
Biascoechea, E., Box 114, 236 Carretera, Stop 33½, Hato Rey, Rio Piedras, P. R.
Blocker, C., 44-19 Ketcham St., Elmhurst, L. I., N. Y.
Boduch, T. S., 11 Tilson Rd., Toronto 12, Ont., Canada
Boffo, A. P., 3313 W. Walnut St., Chicago, Ill.
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Kassel, P., 1571 Sheridan Ave., New York, N. Y.
Kimes, R. W., 6709A Newell St., Huntington Park, Calif.

(Continued on page 56A)

Positions Wanted

ELECTRICAL ENGINEER

B.S.E.E. Illinois Institute of Technology 1948. Age 27. Married. 2½ years Signal Corps. Installation and maintenance of radio equipment. 2 years electronic instrument experience. 1st class radiotelephone license. Desires position with opportunity for advancement. Box 176W.

JUNIOR ENGINEER

Graduate, west coast radio and television school. Single. Age 28. 1st class phone. 2½ years AAF as VHF specialist. Now employed Navy guided missile base. Desires position with television station, preferably maintenance. Will work any where in U. S. Box 177W

JUNIOR ENGINEER

College Junior, Syracuse University Age 25; Army experience 3 years VHF link-carrier; amateur license; interested in summer 1948 position. Location irrelevant. Box 169W.

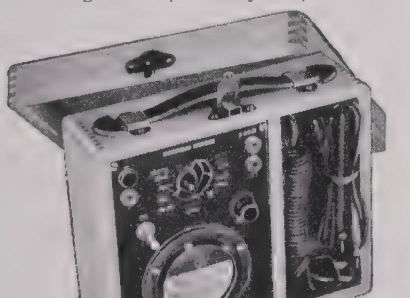
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 24A)

New "Range-Master" Features Protective Built-in Fuse

Encompassing a wide range, and incorporating a standard Littelfuse which protects the meter movement, rectifier, and shunts against overload on all ranges, a new Model 10-F "Range-Master" has been developed by **Bradshaw Instruments Co.,** 348 Livingston St., Brooklyn 17, N. Y.



The 10-F covers the following ranges: (1) capacitance—0.001–0.1, 0.01–1, 0.1–10 μfd.; (2) a.c.—0–.15, 0–1.5, 0–15 amperes; (3) a.c. voltage—1, 10, 100, 500, 1000 volts; (4) d.c. voltage—10, 100, 500, 1000 volts; (5) d.c.—1, 10, 100, 1000 milliamperes; (6) resistance—0 to 10,000, 100,000, 1 megohm; (7) special high-range ohmmeter to 2 megohms and 20 amperes without external battery; and (8) sensitive a.c. microammeter to 1100 microamperes.

Direct reading on all ranges insures rapid circuit analysis. Using wire-wound calibrating controls for accuracy, and an exclusive sealed-in manganin wire-wound shunt, the 10-F employs 1% carbofilm multipliers. Portable model measures 8¾″×7¼″×4″; bench model, 5¼″×6¾″×2¼″.

(Continued on page 57A)

NOW! SELF-CONTAINED, EXPERIMENTAL

SCHOOL & INDUSTRIAL LAB EQUIPMENT

Kepco Laboratory Multiple Power Supply Model 103, available separately.

Kepco Electronic Instruction Panel Model 104, available separately.

Now you can perform electronic experiments simply, easily with the Kepco Electronic Instruction Panel. Here is a teaching aid that graphically illustrates vacuum tube principles — enables all students to grasp fundamentals in the laboratory.

Extremely versatile, the Kepco Electronic Instruction panel covers a wide range of tubes, comes with a packet of 23 keyed interchangeable circuit charts, 3 master charts and 12 blank keyed sheets for additional experiments. Panel contains 3 octal tube sockets, 18 binding posts. By placing a keyed circuit diagram on the panel and wiring the circuit, students determine tube and circuit characteristics.

For a basic electronic instructional aid that vastly simplifies the teacher's task, it's the Kepco Electronic Instruction Panel!

Now you can eliminate the use of cumbersome separate voltage supplies with the Kepco Laboratory Multiple Power Supply. Designed to be used with the Kepco Electronic Instruction Panel, this versatile, compact, easy-to-use unit supplies four commonly used voltages, is invaluable for the school or industrial laboratory.

CHECK THESE FEATURES:

Two continuously variable B supplies, adjustable from 0-300 volts at 120 m.a.
Variable (grid) supply, adjustable from minus 50 to plus 50 volts at 5 m.a.
6.3 volt filament supply at 5 amperes.
All connections made to sturdy, front panel binding posts.
Input: 105 to 125 volts, 50 to 60 cycles.
Two 5Y3 rectifiers, Two 6Y6 control tubes.
16″ long, 8″ high, 8¾″ deep. Wgt.: 28 lbs.

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Kepco LABORATORIES INC.
Electronic Instruments

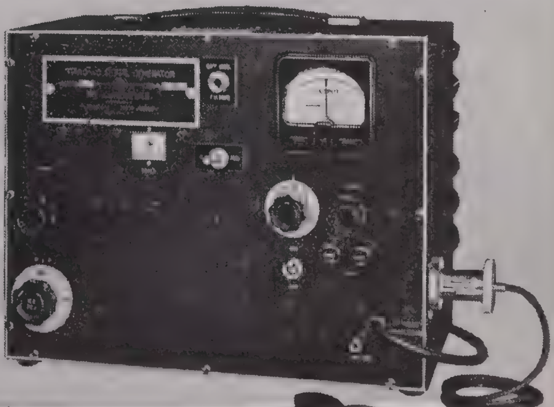
149-14 41st Avenue
Flushing, New York

FREQUENCY MODULATED SIGNAL GENERATOR

MODEL 78FM

86-108 MC

Also Available For Other Frequency Ranges



1 to 100,000 MICROVOLTS
Variable Output
With Negligible Carrier Leakage

MODULATION: 400 cycle internal audio oscillator. Deviation directly calibrated: 0 to 30 kc. and 0 to 300 kc. Can be modulated from external audio source.

Audio fidelity is flat within 2 db from dc to 15,000 cycles. Distortion less than 1% at 75 kc. deviation.

The Model 78FM when used with Measurements Model M-275 Converter provides output in the IF ranges of 4.5, 10.7 and 21.7 mc.

Circular on Request

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Vacuum Tube Voltmeters
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MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

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If you have a special crystal problem, James Knights is equipped to build crystals to your exact specifications—no matter what they may be. Because of a special production line for short runs, the price is right—whether you need one, ten or several thousand crystals!

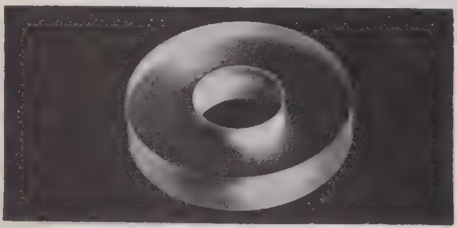
In addition, James Knights fabricates a complete line of crystals to meet every ordinary need—precision built by the most modern methods and equipment.

Fast service is yours, too! Two company planes save hours when speed is important.

Your inquiries—and crystal problems—are invited.

Send For New James Knights Catalog

JK 1½" Doughnut Quartz Crystal



The **JAMES KNIGHTS** *Co.*

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(Continued from page 48A)

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Roach, W. E., Box 72, Lawrenceburg, Ky.
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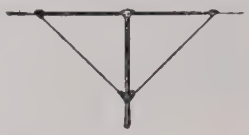
PREMAX

Television---FM ANTENNAS

Premax Television and FM Antennas have, in actual operation in what were considered unfavorable locations, been found to materially reduce man-made electrical noises and improve the reception of the set.



FM-254—Extended V-type Dipole Antenna for all frequencies between 44 and 216 mc. Extended arm V dipole element is mounted on hardwood mast and crossarm. Permits proper impedance matching to 300-ohm line, for TV or FM reception.

FM-130—Adjustable V Dipole Antenna, for maximum reception of TV and FM. Dipole arms of heat-treated aluminum may be adjusted to any angle for best reception to counteract man-made electrical noise or reflected signal. Provides better reception than any straight dipole in congested areas.

FMT-330—Similar to FM-130 described above excepting it has a built-in reflector element which is also fully adjustable for best results in getting more distant TV and FM stations. Insures optimum reception of signals from all stations within line of sight.

Premax Products
Division of Chisholm-Ryder Co., Inc.

4811 Highland Ave. Niagara Falls, N.Y.

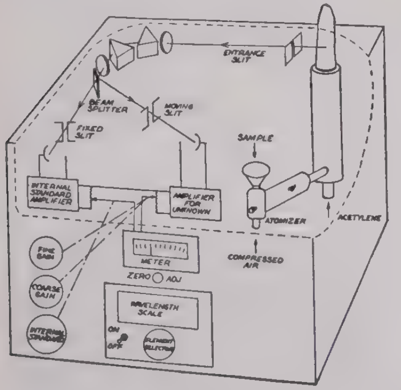
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 55A)

Internal Standard Flame Photometer

The Model 52-A Flame Photometer has been developed by the **Perkin-Elmer Corp.,** Glenbrook, Conn. for the analysis of the alkali and alkaline-earth elements. Provision for internal standard measurements with their higher accuracy is featured with the new instrument. The instrument also incorporates an a.c. amplification system with chopped light and synchronous amplification at the output. This provides the amplifier system with high sensitivity and maximum flexibility. Sodium, potassium, and lithium may be detected in concentrations down to 1/10 part per million. Good analyses can be made anywhere in the range from 10 to 1000 ppm. Calcium may be detected down to 1 part per million. For the other alkaline earth elements the sensitivity is somewhat less. 5 cc of sample is required for each determination, and accuracies of plus or minus 1% to 2% of the amount present are obtainable in the range of favorable concentrations.

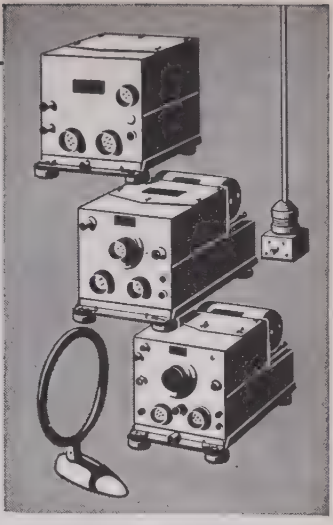


The cutaway drawing shows schematically the general arrangement and operating principles. The sample is poured into the inlet funnel of an atomizer. A fine fog separated from the atomized spray in the glass atomizer chamber is blown into the base of the burner. When mixed with gas and burned, it colors the flame with the characteristic spectra of the salts it contains. The entrance slit of a two-prism monochromator looks directly at the center of the flame just above the top of the burner. Light from the flame is dispersed into a spectrum and divided by a beam-splitting mirror so that part falls on a fixed exit slit and part on a movable one.

For internal standard measurements, 2 phototubes measure simultaneously the amounts of light at two different wavelengths in the spectrum. One of them is set for the wavelength of the lithium emission lines used as the internal standard; the other is adjustable for the selection of different elements. The intensities of the lights falling on the two are balanced

(Continued on page 58A)

VHF COMMUNICATION
and **LF** NAVIGATION SYSTEMS
meet every Operational Need



THE A.R.C. TYPE 11A

Meets basic needs by providing for VHF Transmission, LF Range Reception and Rotatable Loop Navigation.

THE A.R.C. TYPE 17

A 2-way VHF equipment, including a tunable VHF Receiver and a 5-channel, crystal controlled VHF Transmitter.

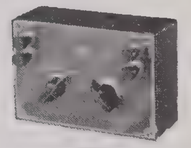
THE A.R.C. TYPE 12 (Above)

Combines the advantages of the Type 11A and the Type 17, offering 2-way VHF, together with LF Range Reception and Rotatable Loop Navigation.

All units of these systems have been Type-Certificated by the CAA. For the highest standards of design and manufacture and the finest in radio equipment, specify A.R.C.

ARC
Aircraft Radio Corporation
BOONTON, NEW JERSEY
DEPENDABLE ELECTRONIC EQUIPMENT SINCE 1928

FOUR NEW B&W INSTRUMENTS



B & W SINE WAVE CLIPPER
Model 250

A device for generating a test signal particularly useful for examining the transient and frequency response of audio circuits.

B & W FREQUENCY METER
Model 300

An accurate and convenient means of making direct measurements of unknown audio frequencies up to 30,000 cycles. Integral power supply.

B & W AUDIO OSCILLATOR
Model 200

A source of stable, accurately calibrated frequencies between 30 and 30,000 cycles. Self-contained power supply.

B & W DISTORTION METER
Model 400

Ideal for measuring low level audio voltages and determining their noise and harmonic content. Self-contained power supply.

Write for descriptive folders and prices.

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STATION WHKC ...Selects TECH LABS

VERTICAL ATTENUATORS

for new CONSOLE INSTALLATION

The flick of a finger operates the patented "Gove" Vertical Attenuator. Representing the very latest in broadcast components, these units are suitable for every type of sound equipment from elaborate broadcast stations to the simplest P.A. system. Unit gives smooth easy operation and can be cleaned from front of panel by removing escutcheon. Completely shielded and dust proof.

Courtesy of WHKC,
United Broadcasting Co.

Write for Descriptive Bulletin

TECH LABORATORIES, INC.
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 57A)

against each other, to read their ratio directly. Of course, direct intensity measurements may also be made without the use of the internal standard.

Features that are not shown in the figure are the vibrating shutter and synchronous rectifier included to permit the use of ac amplification, and the connection from the element selector and wavelength scale to the moving slit. Additional amplification makes the final output large enough to read on a meter.

The instrument can burn either propane or acetylene merely by changing the grid on the top of the burner. The flame recommended for the determination of sodium, lithium and potassium is propane and air. Acetylene is used to give a hot flame for the determination of the other elements. The amplifier operates on 110-volt, 50- or 60-cycle power. Compressed air at 20 to 150 pounds per square inch is needed for the atomizer. Pressure regulators are included for the air and gas supplies.

Phase-Modulated Microphone

Announcement of the "Tru-Sonic Phase-Modulated Model C-1" microphone has been made by **Stevens Manufacturing Corp.**, 10416 National Blvd., Los Angeles 34, Calif.

The principle of carrier-frequency phase modulation is employed. Measurements of the ovoid-shaped pickup assembly are $1'' \times 1\frac{1}{4}''$.

Other features claimed by the manufacturer are: (1) true and absolute linearity of response—low response is linear to one-half cycle in 24 hours, (2) no distortion can be read or detected, (3) no arc-over or breakdown, (4) pressure-operated at all frequencies, (5) polar pattern at all frequencies—almost completely one-half sphere, down 5 db at 90° off the axis, (6) signal-to-noise ratio at least 11 db higher than the best prior microphones, (7) pickup unit contains only the acoustic valve and carrier-matching coil. It is of such rugged construction that the valve assembly may be thrown on the floor without damage.

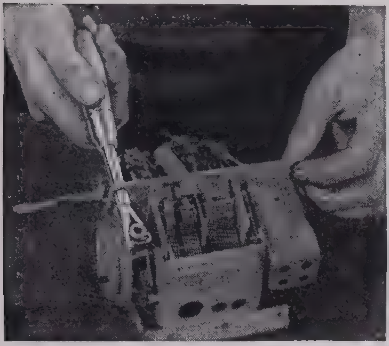
(Continued on page 59A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 58A)

Grommet Inserter



This tool has recently been developed by **D. B. Rich Manufacturing Co.,** 6217 N. Melvina Ave., Chicago 30, Illinois to efficiently simplify grommet inserting.

Each insertion takes only a few seconds. The nose of the tool is slipped through the hole which is to receive the grommet. The operator places a grommet into the claw nose, withdraws the tool, and the grommet is automatically inserted in position. Snug, perfect fitting is insured because undersized grommets need not be used to make inserting easier. Damage to grommets ordinarily caused by forcing and jamming methods is eliminated when using this new device.

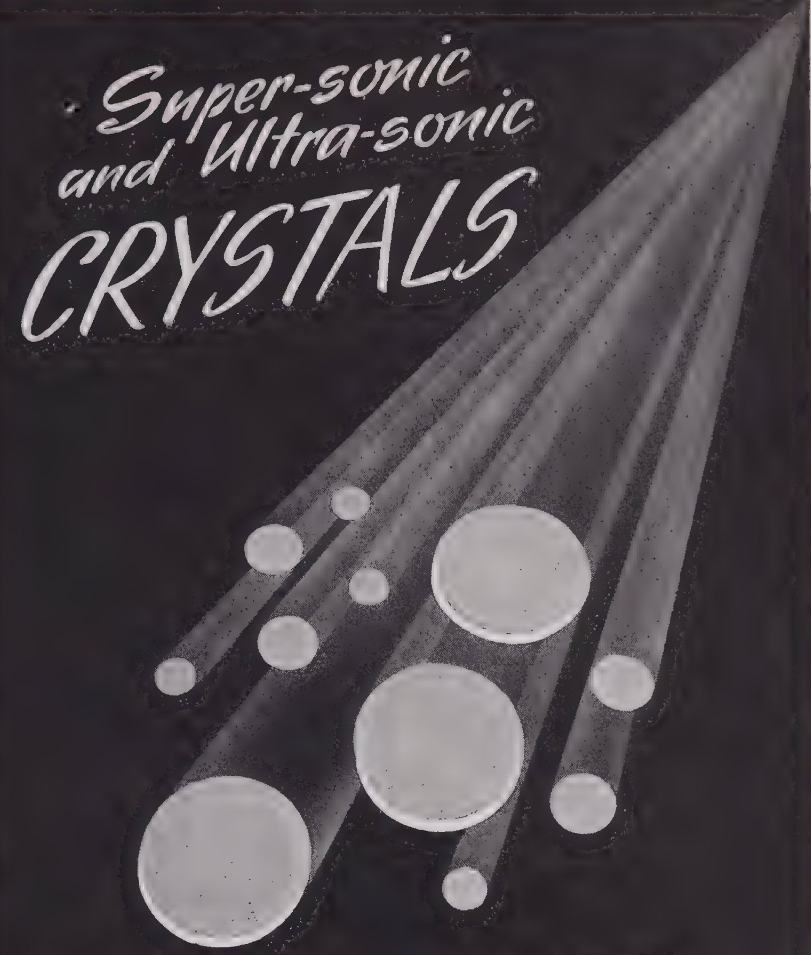
The inserting claw has only one moving part, decreasing the possibility of malfunction. It is available in four standard sizes for instering $\frac{1}{4}''$, $\frac{5}{16}''$, $\frac{3}{8}''$ and $\frac{7}{16}''$ grommets. Custom sizes made to order.

Constant Voltage for Mercury-Vapor Lamps

Announcement of the Sola Type CVM-1 constant voltage ballast transformer by **Sola Electric Company,** 2525 Clybourn Ave., Chicago 14, Illinois, marks the formal extension of the Sola constant-voltage principle to the field of high-pressure, high-intensity mercury-vapor-lamp controls. The Type CVM-1 ballast transformer is a unit specifically designed to protect and stabilize the operation of the G. E. Type UA-4 mercury-vapor lamp and offers advantages over high-reactance ballast transformers.

Operation of the lamp is completely stable and free from the effects of improper or widely varying line voltage. Lamp life is increased by preventing over-voltage operation. Lamp outages resulting from momentary voltage drops are eliminated. There can be no damage to the lamp from improper selection of primary taps. Constant spectral distribution of light output is maintained. Inherently high input power factor permits operation of lamp on 115-volt lighting circuits. The Type CVM-1 is entirely automatic, has no moving parts, and requires no maintenance or adjustments.

(Continued on page 60A)



Already in wide use by sonic-equipment manufacturers and research laboratories for such diversified applications as disintegration of bacteria, emulsification of unlike liquids, and pasteurization of milk, Reeves-Hoffman super-sonic and ultra-sonic crystals are available in ranges from 15 kc to 15 mc.

According to specification, these crystals can be provided with optically flat surfaces or with spherical or cylindrical contours. Plating in either gold or silver can be made to any specified degree or area. Designed for your particular application, sizes range from 3"x3"x3" to thickness of .003".

REEVES-HOFFMAN
CORPORATION
CHERRY AND NORTH STREETS • CARLISLE, PA.

This signficant new book points the road to future research

Preparation and Characteristics of Solid Luminescent Materials

Published by arrangement with the American Physical Society, under the auspices of the National Research Council. Edited by GORTON R. FONDA, General Electric Company, and FREDERICK SEITZ, Carnegie Institute of Technology.

This volume is the outgrowth of a conference of leading scientists and engineers. They reviewed work of the past and present, and considered possible approaches to new research. The book consists of twenty-nine papers presented, and an account of the discussions which followed.

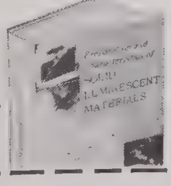
Understanding of Phenomena and Theory of Storage

The book summarizes the information necessary to an understanding of luminescence phenomena, serves as a guide in preparing phosphors, and demonstrates the dependence of luminous characteristics upon measurable features of chemical composition. It explains theories now being used to determine more exactly the processes involved in the storage of luminescence energy, and describes excitation and emission phenomena.

Factors Affecting Fluoresence Characteristics

The book also deals with factors which affect fluorescence characteristics. Measurement, proper organization of experiments, and induction and decay of stored energy are discussed.

1948 459 pages $5.00


Preparation and Characteristics of SOLID LUMINESCENT MATERIALS

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Please send me, on 10 days' approval, a copy of PREPARATION AND CHARACTERISTICS OF LUMINESCENT MATERIALS. If I decide to keep the book, I will remit $5.00 plus postage; otherwise I will return the book postpaid.

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

Constant-voltage ballast transformers are also available, or under development, for a number of other mercury-vapor-lamp applications.

Recent Catalogs

• • •On "the magic of making television picture tubes," an illustrated folder in color by the **Dept. of Information, R.C.A.,** 30 Rockefeller Plaza, New York 20, N. Y.

• • •On how other plant engineers and electrical maintenance men are using snap-action switches, **Micro Tips by Micro-Switch,** Freeport, Ill.

• • •On how oscillograph operation was unaffected in high acceleration and shake-table tests, in **"CEC Recordings,"** by **Consolidated Engineering Corp.,** 620 N. Lake Ave., Pasadena 4, Calif.

• • •On various types of crystal units including a plated-type wire-mounted unit, hermetically sealed and filled with dry nitrogen. Fundamental frequencies from 1 to 2 Mc can be supplied with tolerances from 0.02% down to 0.003% over a temperature range—55 to 90 C°, by **Standard Piezo Co.,** P. O. Box 164, Carlisle, Pa.

• • •On high-strength corrosion-resisting alloys with a chart and an offer of free samples to test under your own conditions on page 1, by **Haynes Stellite Co.,** Kokomo, Ind.

• • •On a chimney mount antenna base, extremely light weight and rapidly installed (antennas may be mounted in series), by **South River Metal Products Co.,** South River, N. J.

• • •On capacitors, contacts, rectifiers, resistors, switches, vibrators, welding tips and holders, and various special metals and alloys, by **P. R. Mallory & Co., Inc.,** 3029 E. Washington St., Indianapolis 6, Ind.

• • •On antennas and a chart by Charles Valach on rf connector characteristics, the **Amphenol Engineering News, by American Phenolic Corp.,** 1830 So. 54th Ave., Chicago 50, Ill.

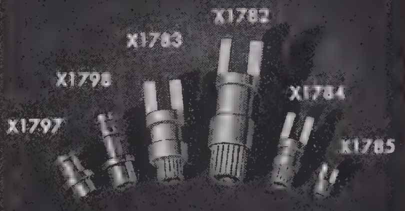
• • •On their 56th Annual report for the year ended December 31, 1947 by **Philco Corporation,** Lioga & C Sts., Philadelphia 34, Pa.

• • •On a newly designed Model HPL High Speed Recorder. Requests for the bulletin "Sound Advances" will be promptly complied with by **Sound Apparatus Co.,** 233 Broadway, New York 7, N. Y.

• • •On Operation Recorders, with a guide to assist in determining their selection and use, "The Graphic," Bulletin 247 by **Esterline-Angu~ Co., Inc.,** Indianapolis, Ind.

6 NEW TERMINALS JOIN THE CTC LINE

Hollow lugs speed wiring from top or bottom of terminal board.

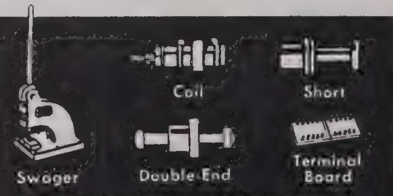


Lugs shown actual size. Notice the midget split lug for hearing aids and other small-space applications. Ask for prices by code number.

These new CTC terminal lugs for quick, easy, neat connections are typical of the broad line in midget, short, turret, double-end and split types . . . in sizes to meet widely varying needs. They're all strongly made of quality brass, heavily silver plated; yet they're free from surplus metal that would draw heat and slow down soldering. Their tolerances are uniform enough for automatic swaging. And, of course, like all CTC components and hardware, they're guaranteed for materials and workmanship!

CUSTOM SERVICE

Chances are you'll find the terminal lugs you need in the CTC standard line. It's wise to check first. If not, CTC will custom-engineer lugs to your specifications. A discussion of your requirements will not obligate you in any way.



Custom or Standard
The Guaranteed
Components

CAMBRIDGE THERMIONIC CORPORATION
456 Concord Avenue, Cambridge 38, Mass.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

• • •On multipurpose step-down transformers with five wiring schematics to illustrate their uses and advantages, by **Electran Mfg. Co.,** 4587 N. Elston Ave., Chicago 30, Ill., in their bulletin 47A.

• • •On new and more complete data on all commercially available types of "Silastic" the Dow Corning Silicone Rubber, in "Silastic Facts No. 5," a 16 page booklet by **Dow Corning Corp.,** Midland, Mich.

• • •On a list of relays, timing devices, and location of sales engineering offices in the 1948 catalog by **Potter & Brumfield Sales Co.,** 549 W. Washington Blvd., Chicago 6, Ill.

• • •On complete and kit television receivers with listings of twenty-five prominent manufacturers in the field, "The Rider Television Manual," Volume 1, by **John F. Rider, Publisher, Inc.,** 404 Fourth Ave., New York 16, N. Y.

• • •On electronic timers employing RCA thyratrons 2D21 or 2050 with several schematic diagrams of circuits by **RCA Tube Dept.,** Harrison N. J. Request March issue.

• • •On "Trancors by Lenkurt," a new 24-page folder describing the complete line of moulded magnetic cores, core assemblies, and filters manufactured by **Lenkurt Electric Co.,** 1129 County Road, San Carlos, Calif.

PRODUCT INFORMATION

in 72 Engineering Classifications

for 2000 Supply Firms

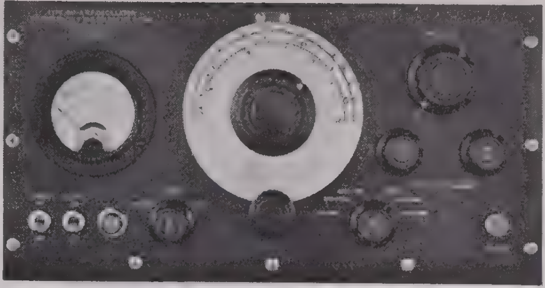
will appear in your 1948 I.R.E. Yearbook coming out in July.

An alphabetical listing is given for all manufacturers who have provided us up-to-date product data. Listing shows the firm's complete radio-electronic line.

Complete product index is given on 120 leading firms who are advertising in the Yearbook.

"Look in the I.R.E. Yearbook."

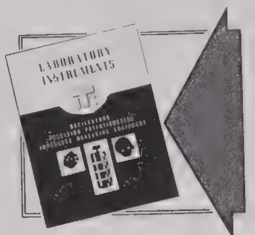
NEW R-F OSCILLATOR



for general laboratory use and as a signal source for R-F bridges

Midwest Sales Engineering Office:

Alfred Crossley & Assoc.
549 W. Randolph St., Chicago 6, Illinois
STAte 7444



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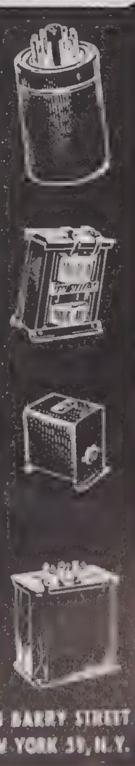
- 100 kc to 10 Mc
- High output—approximately 30 volts
- 50-60 Ω output impedance
- Internal modulation
- Output voltmeter
- Compact design

Write today for Bulletin 408 containing complete information and specifications on the Type 410-A R-F Oscillator.

TECHNOLOGY INSTRUMENT CORP.
1058 MAIN STREET, WALTHAM 54, MASS.

Sign of Transformer Reliability



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Consult KENYON about your transformer problems.

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by **FREED**

No. 1010 Comparison and Limit Bridge. Self contained. A.C. operated.

No. 1020 Direct Reading Megohmmeter up to 1,000,000 megohms. Self contained. A.C. operated.

No. 1040 Wide Range Vacuum Tube Voltmeter.

No. 1030 Direct Reading Low Frequency "Q" Indicator — "Q" .5 to 500 — Frequencies from 50-50 000 cycles.

No. 1110 Incremental Inductance Bridge.

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DIALCO

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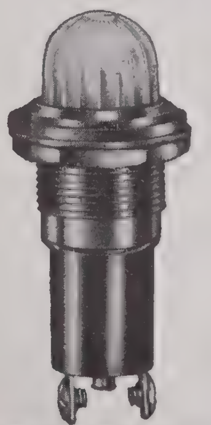
PLN SERIES—Designed for NE-51 Neon Lamp



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Write for descriptive booklet

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News—New Products

Atomic Energy Commission Orders Radiochemical Compounds

The Atomic Energy Commission has enlisted the services of **Tracerlab, Inc.,** 55 Oliver Street, Boston, Mass., to manufacture and stock a number of compounds tagged with carbon-14, for which there is a widespread need in research problems.

A substantial contribution to more extensive use of radioisotopes in research is expected to be achived in a new cooperative venture between the Atomic Energy Commission and private industry.

This new program should have several beneficial results. First, a variety of tagged compounds will be made available to many research groups who otherwise would not be in a position to synthesize them. Second, it is hoped that the synthesis of these compounds on a relatively large scale will result in a substantially lower cost than if they were made for a single customer. Third, it is believed that considerable time will be saved by having such compounds available for immediate shipment upon receipt of an order approved by the Atomic Energy Commission.

To obtain, apply for Form 313, "Application for Radioisotope Procurement," to the Isotopes Division, U. S. Atomic Energy Commission, P. O. Box E, Oak Ridge, Tenn.

Barium carbide tagged with carbon-14 is available for immediate delivery at $150.00 per millicurie with a specific activity of two millicuries per millimole. The cost of the carbon-14 is included in this price.

Carbon-14-labeled sodium cyanide is available from stock at a price of $250.00 per millicurie.

Interesting Abstracts

Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J., have released an explanatory booklet describing "Intelex," and automatic reservation exchange for airline travel, which is comparable to an automatic telephone exchange.

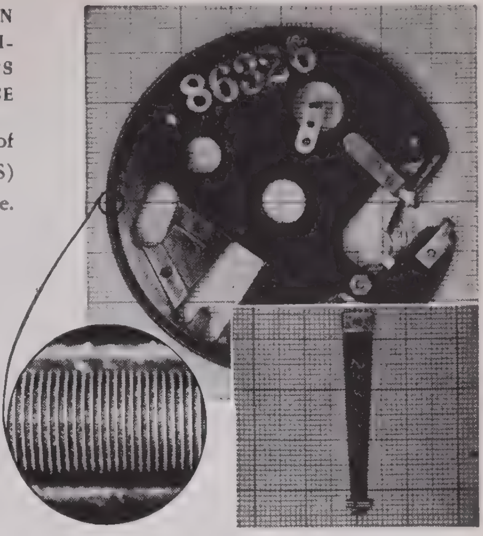
This electrically operated device almost entirely eliminates manual operation, and decreases the time expended in making a reservation from hours to a matter of seconds.

Intelex automatically checks availability of the space requested. If available, the machine advances its storage recorder one place for each seat requested, and answers over the teleprinter by repeating the message and adding a serial number. This serial number tells the clerk that the space requested is confirmed.

The complete operation normally requires less than 20 seconds and eliminates entirely the possibility of making duplicate sales.

NEY PRECIOUS METALS IN INDUSTRY

NEY-ORO #28B BRUSH CONTACT ON ADVANCE WIRE WOUND POTENTIOMETER RUNS 4,300,000 SWEEPS WITH NO CHANGE IN RESISTANCE



Mandrel and brush shown 40% full size. Section of mandrel 6⅔ x magnification.

Examine these unretouched photographs of mandrel (wound with Advance #36 B & S) and brush adjusted for 50 gms pressure. There is no appreciable wear on the winding after 4,300,000 sweeps of the brush and the wear on the brush is less than .008″. Throughout the test there was no perceptible change in resistance. Truly a remarkable performance when you consider the additional fact that the test was conducted at a speed of 37.5 cycles (75 sweeps) per minute, considerably faster than normal operation. The test was conducted by a leading manufacturer of precision equipment and the complete test data is available on request. It is, we believe, further convincing evidence of the interesting possibilities offered by the use of Ney Precious Metal Alloys in industrial and scientific applications.

Write or phone (Hartford 2-4271) our Research Department.

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● **INSTANTLY** ... direct reading. No computation.
● **ACCURATELY** ... to a frequency determination of 0.05%.
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Used effectively in leading laboratories, such as: Harvard University, Bell Aircraft Corp., and Hamilton Standard Propellers ... for measuring natural frequencies or speed of rotating objects, checking or calibrating tachometers, oscillators, impulse generators, similar equipment.

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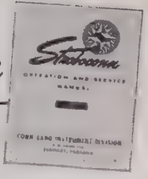

Please send *free* Strobocon folder containing information about operation and application of this new precision instrument. I understand this places me under no obligation.

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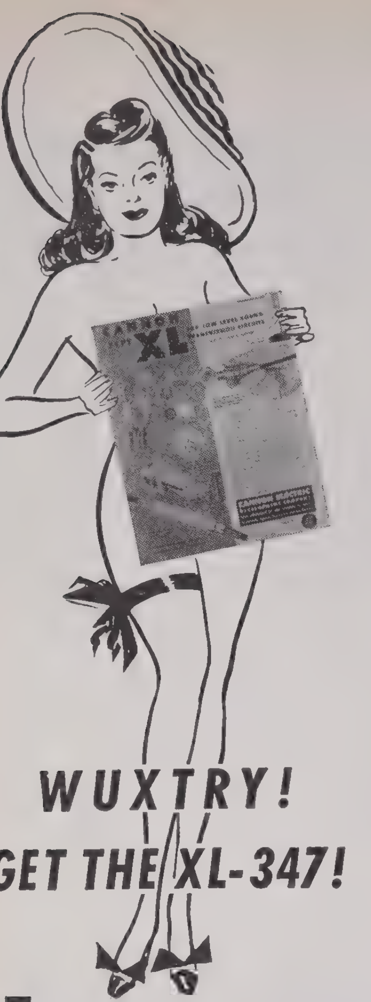

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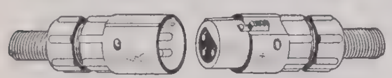
GET THE XL-347!

THE CONNECTORS WITH TECHNICAL SUPERIORITY... favorite of sound technicians in night clubs, radio stations, motion picture studios—and also used extensively by "hams". Cannon Connectors require a minimum of servicing—that's why sound men prefer Cannon.



XL-3-12 PLUG
LIST $1.20

XL-3-11 PLUG
LIST $1.25

Latch-lock keeps plug *positively* connected—no scratchy connections with loose coupling nuts. It stays connected!

Available from more than 300 distributors: In NEW YORK, Harvey and Newark Radio. In CHICAGO, Allied, Newark and Walker-Jimieson.

We'll send the XL-347 and the RJC-2 for the asking. Address Department F-377.

SINCE 1915

CANNON ELECTRIC
Development Company

3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.
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WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Standardized Interchangeable Components For New Welding Guns

Standardized spot-welding guns designed with and constructed from standardized interchangeable component parts are now being produced by **Progressive Welder Co.,** 3050 E. Outer Drive, Detroit 12, Michigan.

Seven basic gun types, in heavy-duty and standard-duty versions, will take care of 95% of all gun welding requirements. Moreover a gun can be quickly converted to a different job by simply changing one or two standardized parts.

With this standardization of components it is possible to obtain as many as 57,600 variations with a single basic gun chassis, varying only jaw extensions and standard electrodes.

Jaw extensions are available in increments of length from 1 to 6 inches and with four (0°, 10°, 20° and 30°) variations for the angle at which electrodes are mounted. Chassis jaws are equipped with clamp-type locks, while jaw extensions have O-ring type seals effectively preventing leakage.

Special variations include manually retractable or rotary jaws, to clear extremely wide flanges; special jaw extensions and point adaptors to suit unusual conditions; linkages to provide extra long stroke; stroke decreasers (to reduce the normal return stroke of a gun for exceptionally fast operation); self-locking hydraulic cable terminal clamps which permit the gun to be swiveled free of the cable until welding pressure is applied.

Recent Catalogs

• • •On a wide variety of special military motors, with circulars briefly describing their specialized tasks, also small 5- and; 10-watt output two-phase servo motors; by **Eastern Air Devices,** 130 Flatbush Ave., Brooklyn 17, N. Y.

• • •On electric branding irons, with inclosed lists of instructions for ordering, materials that may be branded, use of the iron, and suggestions for designing a brand which will be effective and economical by **Hexacon Electric Co.,** 181 W. Clay Ave., Roselle Park, N. J. Request No. 300.

• • •On Kodak Linagraph films and papers for use in instrument recording, issued by **Industrial Photograph Division, Eastman Kodak Co.,** Rochester 4, N. Y.

• • •On a price list of magnetic wire, and a listing of sales offices and warehouses in important cities, by **Essex Wire Corp.,** Fort Wayne 6, Ind.

• • •On small high-voltage capacitors, designed exclusively for television with three types of terminals for flexibility and convenience and made with "Ceramic-X," by **Centralab Division of Globe-Union, Inc.,** Milwaukee 1, Wis.

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MANUAL DIVISION M-2 MONTCLAIR, N.J.

RUBBER RECIPE

Rubber compounds to the tune of some 35 million pounds a year go into Bell System plant. Each compound must meet many requirements for resistance to humidity, oxygen, ozone, light and abrasion. The right properties depend on skillful selection and compounding of ingredients; this is one of the jobs of Bell Laboratories.

Sulphur, one essential ingredient of rubber, can also be corrosive. That seemed to rule out rubber on telephone cords. But Bell chemists found that if they held sulphur to the bare minimum, corrosion ceased. Now your handset cord has long life, is less susceptible to moisture as, for example, from a wet umbrella.

Connecting your home to the telephone wire on the street is a "drop" — one hundred feet or more of rubber-insulated wire. Once this wire was protected from ozone, light and abrasion by an impregnated cotton braid; but water leached the impregnant, and the braid rotted. Bell chemists tested scores of synthetics, and selected neoprene as an exterior covering with many times the life of braid.

Rubber is only one of many types of insulation developed by the Laboratories for the Bell System; insulation is only one of the Laboratories' problems in providing a quick, economical path for your voice.

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EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

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RAYTHEON SPEECH EQUIPMENT

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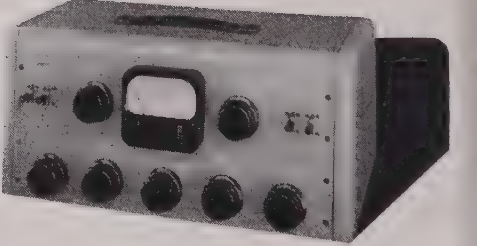
facilities . . . or simple, low-cost equipment
to suit your limited requirements . . .

Look to RAYTHEON for All Your Needs

RC-11 STUDIO CONSOLE

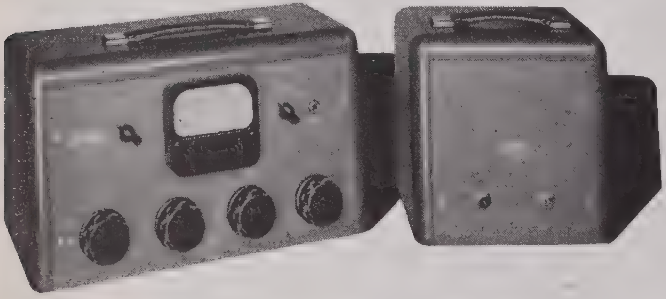
NOW WITH CUE POTS FOR TWO TURNTABLES

Provides complete high-fidelity speech input facilities with all control, amplifying and monitoring equipment in one cabinet. Seven built-in pre-amplifiers, nine mixer positions, cue attenuators for two turntables. Simple, positive controls reduce operational errors. Frequency response—2 DB from 30 to 15,000 cycles; Distortion—less than 1% from 50 to 10,000 cycles; Noise Level—minus 65 DB's or better. Meets all FCC requirements for FM.



RPC-40 PORTABLE CONSOLETTE

Ideal for remote pickups yet complete enough to serve as a studio console. Four input channels for microphones or turntables, high level mixing, two output lines. Two RPC-40's interconnected provide 8-channel mixing—a feature of special interest to new TV stations planning future expansion.

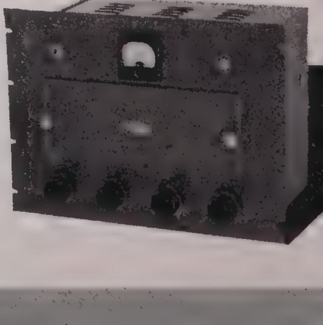


RR-30 REMOTE AMPLIFIER 3 CHANNEL

A lightweight, easy-to-carry combination of amplifier and power supply—simple and quick to set up. Provides three high-fidelity channels, excellent frequency response, high over-all gain.

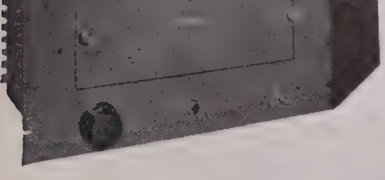
RR-10 REMOTE AMPLIFIER SINGLE CHANNEL

A complete, self-contained unit with built-in power supply. An excellent low-cost amplifier for remote pickups requiring only one high-fidelity channel.



RL-10 VOLUME LIMITER

Engineered for high-fidelity AM, FM or TV speech input. Increases average percentage modulation without distortion.



RP-10 PROGRAM AMPLIFIER

High gain, low distortion, excellent frequency characteristics. For rack or cabinet mounting.

RAYTHEON MANUFACTURING COMPANY

WALTHAM 54, MASSACHUSETTS

Industrial and Commercial Electronic Equipment, FM, AM and TV Broadcast Equipment, Tubes and Accessories

BOSTON	**CHICAGO**	**LOS ANGELES**	**SEATTLE**
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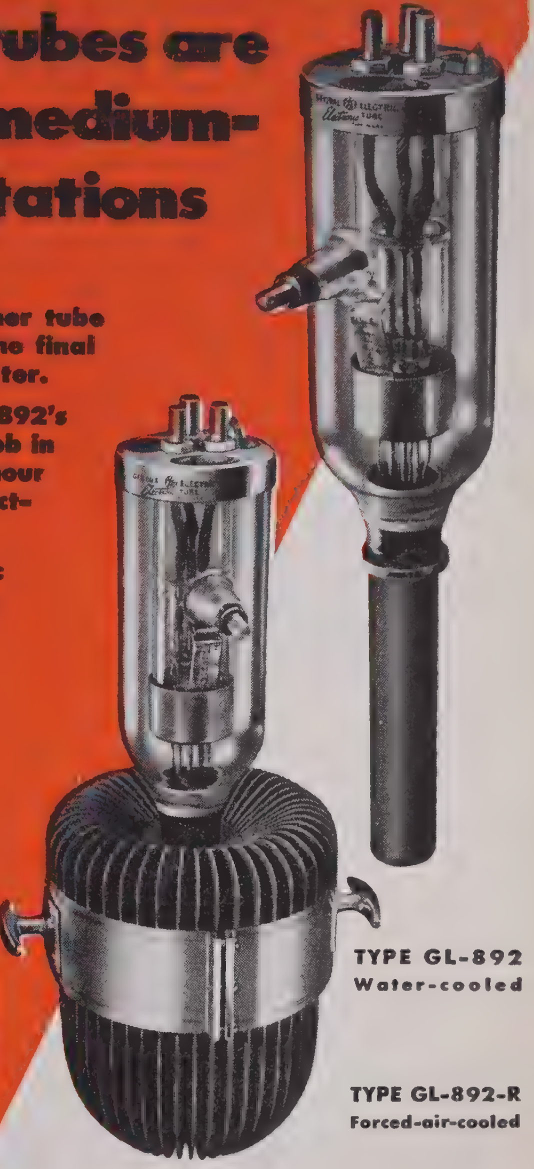
EXPORT SALES AND SERVICE IN FOREIGN COUNTRIES

These proved tubes are "money in the bank" for medium-size AM broadcast stations

- **Plenty of power** . . . Either tube in push-pull will handle the final output of a 10-kw transmitter.
- **Dependable** . . . Already GL-892's and GL-892-R's are on the job in scores of stations where a 24-hour day and 7-day week make exacting demands.
- **Long-lived** . . . General Electric superior design and workmanship pay valuable dividends in extra hours of tube service.
- **Versatile** . . . Applications include broadcast and communications work as amplifiers and modulators—also industrial electronic-heating use as oscillators. A plus-feature: the special 2-unit filament will take 2-phase or single-phase a-c current, or d-c.



TYPE GL-892
Water-cooled

TYPE GL-892-R
Forced-air-cooled

YOUR tube investment is soundest when backed by *proved* quality, a *proved* record of performance. In key radio stations—in factories where electronic heating speeds production—GL-892's and GL-892-R's are respected because their performance is well known, their reliability demonstrated many times over. *G-E tubes are a standard by which others may be judged* . . . Builders of equipment, by specifying General Electric tubes, take an important step toward buyer acceptance. Your G-E electronics office gladly will help you choose the correct types for new circuits in the development stage . . . On tubes for replacement, station operators and manufacturers will obtain the fastest, most efficient service from *their nearby G-E tube distributor or dealer*, with same-day delivery a customary feature! *General Electric Company, Electronics Department, Schenectady 5, N. Y.*

	GL-892		GL-892-R	
	Class C Telegraphy	Class C Plate-modulated	Class C Telegraphy	Class C Plate-modulated
Filament voltage	11 v	11 v	11 v	11 v
Filament current	60 amp	60 amp	60 amp	60 amp
Max plate voltage	15,000 v	10,000 v	12,500 v	10,000 v
current	2 amp	1 amp	2 amp	1 amp
input	30 kw	10 kw	18 kw	10 kw
dissipation	10 kw	6.6 kw	4 kw	2.5 kw
Power output (approx), typical operation	14 kw	6 kw	10 kw	5 kw

NOTES: (1) Filament voltage and current are per unit of 2-unit filament. (2) Max frequency for both tubes is 1.6 mc at top plate input; up to 20 mc at reduced ratings.

GENERAL ELECTRIC

161-65-8850

FIRST AND GREATEST NAME IN ELECTRONICS

This is the NEW Astatic

MAGNETO
INDUCTION
PICKUP
they're talking about . . .

. . . And small wonder, indeed, that such a radical departure from established engineering precedent is causing universal comment in the field. The Astatic Magneto-Induction Pickup Cartridge, contrary to operating principles of previous magnetic type units, eliminates the need for "air gaps." Revolutionary? Yes, in construction and equally so in terms of performance. Absence of delicately spaced air gaps means no more trouble or diminishing quality of reproduction due to lint and dust collection. No more need for delicate handling. No more costly, troublesome armature balancing problems. Free of such limitations, the Magneto-Induction cartridge provides peak, unchanging fidelity of reproduction, under consistent service or adverse climatic conditions. It is another major contribution to greater listening pleasure by Astatic. Write for Complete Technical Data, Prices.

TWO MODELS NOW AVAILABLE

MODEL MI-1, Standard Housing

MODEL MI-2, Mumetal Housing*

*Provides increased shielding effect for maximum reduction of hum
[illegible]

Two Equalizer-Amplifier Models Available

Model EA-1, compact unit designed for radio sets and audio amplifiers having insufficient gain for operation of Astatic Magneto-Induction Pickup Cartridges. Provides "bass-boost."

Model EA-2 Equalizer-Amplifier, self-powered, provides adjustable "bass-boost" with adjustable treble "roll-off" and selection of "turnover frequency."

Manufactured under Massa Laboratories License

THE Astatic CORPORATION
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

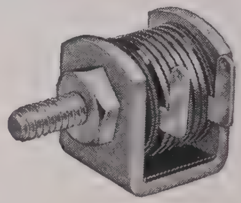
Multimeter for Electrolysis and Cathodic Protection Testing

A multicombination meter designed specifically for electrolysis and corrosion investigations and cathode protection testing has been developed by **M. C. Miller,** 1142 Emerson Ave., W. Englewood, N. J.

With a circuit selector switch, a high-sensitivity, 300 ohms-per-volt millivolt voltmeter covering ranges of 2 millivolts to 100 volts, full scale and high sensitivity, and a 62,500 ohms-per-volt voltmeter with ranges of 100 millivolts to 20 volts full scale, are provided, They may be used separately or simultaneously.

Also provided are: a potentiometer-voltmeter with a high-resistance galvanometer, a battery-operated vacuum-tube voltmeter with ranges from 100 millivolts to 10 volts with 500,000 ohms input resistance, a milliammeter and ammeter with ranges of 1 milliampere to 20 amperes, and a zero-resistance-type ammeter with range up to 2 amperes from self-contained batteries and controls. The ammeters may be used independently or simultaneously with the voltmeters.

Miniature Selenium Rectifier



A miniature selenium rectifier, model number SE 14P 6H, has been designed by **Bradley Labs., Inc.,** 82 Meadow St., New Haven, Conn., for use on all low-current applications where small size and dependability are factors, such as in television preselectors, preamplifiers, and relays.

Rated 110–125 volts a.c. rms, 20 milliamperes d.c. continuous, the tiny rectifier is $\frac{1}{2}''\times\frac{1}{2}''\times\frac{5}{8}''$.

Television Antenna To Increase Reception in "Fringe Areas"

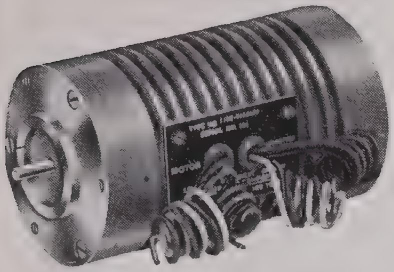
A new-type long-range, high-gain television antenna is being manufactured by **Cole-Warner Corp.,** Dayton, Ohio. It was primarily developed for increased reception in outlying areas and will bring proper reception to localities which heretofore have been unable to pick up a strong enough signal for transmission.

This antenna, the "Telebeam," may be used as a two-stack array, and also as single element, thus making it either a 4, 2, or 1 antenna, depending upon the particular installation requirements.

The manufacturer claims that the product is of unusually rugged construction, having tested it under such adverse conditions as winds up to 70 m.p.h.

(Continued on page 24A)

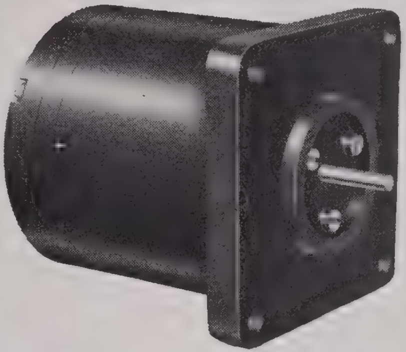
Kollsman now offers a line of special purpose AC units for servomechanisms



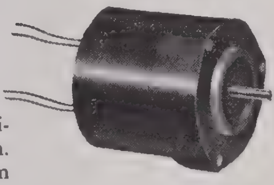
MOTOR DRIVEN INDUCTION GENERATORS — combination of a 2-phase, high-torque, low-inertia induction motor and an induction generator. Used as a fast reversing servo motor. Available with maximum stall torques of .7 (unit shown) to 6.7 (other units) oz/in.

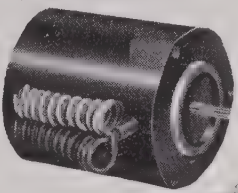
PERMANENT MAGNET GENERATORS — for applications requiring a nearly perfect AC power or potential source. Produce a sinusoidal wave form having a harmonic content under 3% in the unit shown and less than 2% in several other units.

DRAG CUP MOTORS — miniature two-phase motors with extremely fast stopping, starting and reversal characteristics and high torque/inertia ratio, plus the ability to be held continuously at stall condition without overheating. Suitable for many special applications requiring torque of 1 oz/in. or less.

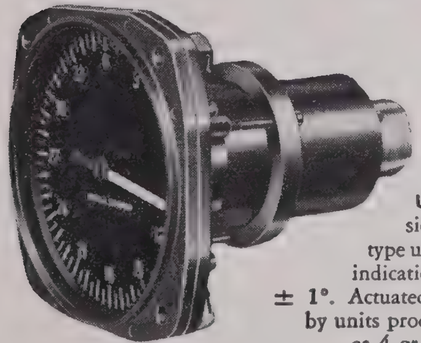


INDUCTION MOTORS — miniature two-phase motors with fast starting, stopping and reversing characteristics and maximum torque at zero r.p.m. Available with maximum torques of .57 (types shown) to 4.6 oz/in. (other units).



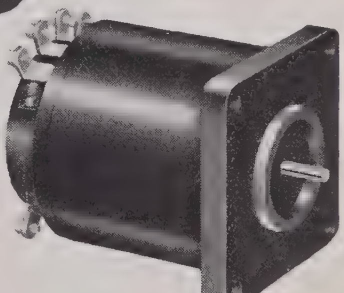


INDUCTION GENERATORS — when fed from an AC source produce a voltage output proportional to the speed of rotation of the shaft and having the same frequency as the source. Used in circuits as velocity control components.



TELETORQUE UNITS — precision built selsyn-type units for remote indication. Accurate to ± 1°. Actuated satisfactorily by units producing as little as 4 gr/cm of torque.

CIRCUTROL UNITS — rotary electro-magnetic devices designed for use as control components in electronic circuits and related equipment. Useful as a phase shifter, resolver, rotatable and control transformer or phase indicator.



For the translation of linear or rotary motion of an actuating mechanism into an electrical impulse signal or indication, the Kollsman line of Special Purpose Motors offers the instrumentation or control engineer a wide variety of devices. Each of the units shown is representative of a comprehensive line of similar type units. They are available in many voltages and frequencies to meet various requirements.

All are high-performance precision devices, light in weight and compact in size. They have been developed by the same engineering staff which has made the Kollsman name synonymous with quality in aircraft instrumentation and control.

Further information on any or all of these units may be had upon request. Write to the Kollsman Instrument Division of Square D Company, 80-66 45th Avenue, Elmhurst, New York.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK · GLENDALE, CALIFORNIA

New, Lighter, More Compact . . .
Easier to Build Into Your Product

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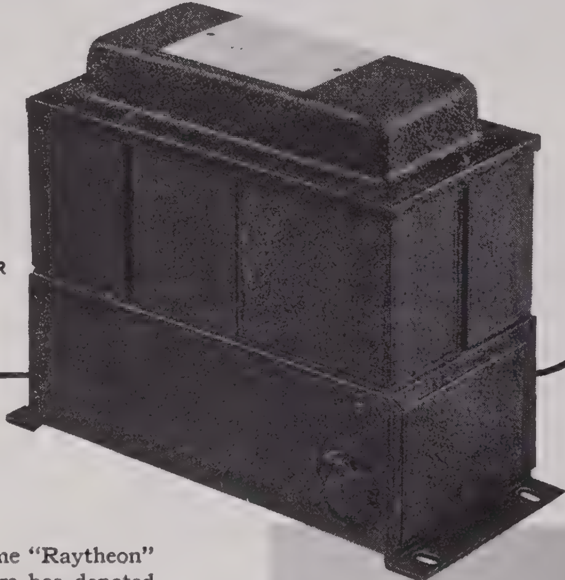
RAYTHEON

VOLTAGE STABILIZER
HEADQUARTERS
Since 1927



For years the name "Raytheon" on voltage stabilizers has denoted advanced design, precision manufacture, rugged construction, reliable and accurate performance . . . in a word — "Excellence in Electronics."

Now, to these highly desirable characteristics, have been added important space and weight saving features . . . features that make it easier and more economical to build dependable, accurate control of fluctuating line voltage right into your product. This entirely new line has been performance-engineered to provide a wide choice of models in service-tested, standard types . . . or you may have special models custom-engineered to suit your special needs.

Get the complete story on this important development at "Voltage Stabilizer Headquarters." Send for it today.

BUILD THESE ADVANTAGES INTO YOUR EQUIPMENT

- Positive control of output voltage to within ± ½%.
- Stabilization at any load within rated capacity.
- Quick response. Stabilizes varying input voltage within 1/20 second.
- Entirely automatic. No adjustments. No moving parts. No maintenance.
- Many designs available with very low harmonic distortion of the output voltage wave at any load.
- Models can be supplied with frequency compensation.
- Single or multiple output voltages.
- Wide range of designs including hermetically-sealed types.

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts

Gentlemen: Please send me copy of your new Voltage Stabilizer Bulletin DL-V-304F.

Name ....

Position ....

Street Address ....

City .... Zone No. .... State ....

News—New Products

(Continued from page 22A)

Cavity Meters for Precise Microwave Frequency Measurements

Designed and manufactured by **Sperry Gyroscope Co., Div. of Sperry Corp.,** Great Neck, N. Y., these instruments are high-*Q* tunable cavities that measure microwave frequencies to absolute accuracies between 1/10,000 and 1/20,000. Designed for applications which require high accuracy and resolution, these frequency meters can be used either as transmission or absorption cavities that provide continuous frequency coverage from 2575 to 3750 and 4500 to 10,500 Mc. Calibration is made against a frequency standard accurate to one part in 100,000.

The cavities are electroformed to obtain minute tolerances, stress-free metal, and a true circular shape. Loaded *Q*'s range from 5000 to 16,000. The tuning plungers use a double wavetrap instead of sliding contact fingers to develop an efficient and stable short circuit. The short coupling distance used between the cavity and the main line reduces reaction of frequency upon coupling.

Four models are available: (1) 291A for 2570 to 3750 Mc, (2) 28A for 4500 to 5600 Mc, (3) 208 for 5350 to 8100 Mc, (4) 901B for 8100 to 10,500 Mc. Delivery information on Model 138 for 8430 to 9660 Mc (not shown) will be sent on request.

Wider Television Programming Facilitated by New Projector

Listed as Type TP-35A, a variation of the basic Brenkert 35-mm. sound-motion-picture projector which will permit projection of standard 35-mm. film directly on to the pickup tube for conversion to video signals has been developed by the **Television Equipment Section, RCA Engineering Products Dept.,** Camden, N. J.

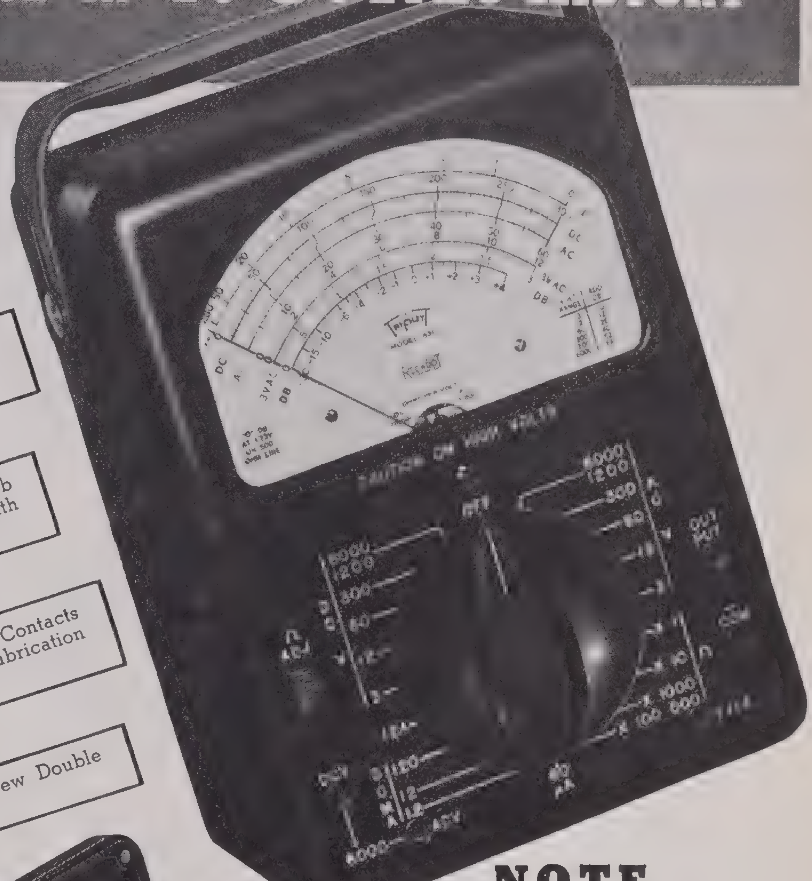
The use of film made for projection at the motion-picture standard of 24 frames per second in a television system requiring 60 interlaced fields or 30 complete frames per second is made possible by employing a sprocket which holds every alternate frame for two scannings and the remaining frames for three.

The "gap-lamp," a pulsed-light source, electronically triggered to provide 60 hihg intensity flashes per second, eliminates the necessity of a shutter, and is virtually free from heat.

A separate cabinet with a 10" picture monitor houses the remote-control switches, exciter lamp, and pulsed-light power supply.

(Continued on page 36A)

GREATEST ADVANCE IN V. O. M. HISTORY



Beautiful Streamlined Instrument.

Large 5½ Inch Meter in special molded case under panel.

Resistance Scale Markings From .2 Ohm To 100 Megohms . . . Zero Ohms Control Flush With Panel.

Only one switch . . . Has Extra Large Knob 2½" Long . . . Easy To Turn . . . Flush With Panel Surface.

New Molded Selector Switch . . . Contacts Are Fully Enclosed . . . will retain lubrication without dust contamination.

Batteries Easily Replaced . . . New Double Suspended Contacts.

All Resistors Are Precision Film Or Wire Wound Types . . . Sealed For Permanent Accuracy.

Unit Construction . . . Resistors, Shunts, Rectifier, Batteries All Are Housed In A Molded Base Built Right Over The Switch . . . Provides Direct Connections Without Cabling . . . No Chance For Shorts.

Inside view cover removed . . . inverted

NOTE the Sensational Improvements

Model 630

37^{50} U.S.A. Dealer Net

Leather Carrying Case $5.75

ADAPTER PROBE FOR TV HIGH VOLTAGE TESTS EXTRA

A completely new Volt-Ohm-Mil-Ammeter that does more . . . . has proved components . . . . and will give a lifetime of satisfaction.

TECH DATA

D.C. VOLTS: 0-3-12-60-300-1200-6000, at 20,000 Ohms/Volt
A.C. VOLTS: 0-3-12-60-300-1200-6000, at 5,000 Ohms/Volts
D.C. MICROAMPERES: 0-60, at 250 Millivolts
D.C. MILLIAMPERES: 0-1.2-12-120, at 250 Millivolts
D.C. AMPERES: 0-12, at 250 Millivolts
OHMS: 0-1000-10,000; 4.4 Ohms at center scale on 1000 scale; 44 Ohms center scale on 10,000 range.
MEGOHMS: 0-1-100
DECIBELS: -30 to +4, +16, +30, +44, +56, +70
OUTPUT: Condenser in series with A.C. Volt ranges

Precision first . . . to Last

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT CO. • BLUFFTON, OHIO

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SECTION MEETINGS

ATLANTA

"What is New in Science and Engineering," by E. S. Lee, General Electric Company; March 16, 1948.

BOSTON

"An Analyzing Oscillograph for Television," by E. G. Nichols and R. P. Abbenhouse, Allen B. DuMont Laboratories, Inc.; April 22, 1948.

CEDAR RAPIDS

"History of Development of KCRG/KCRK," by W. L. Babcock, Radio Station KCRG/KCRK; April 14, 1948.

"FM Transmitter for KCRK," by L. K. Findley, Collins Radio Company; April 14, 1948.

"AM Transmitter for KCRG," by J. W. Smith, Collins Radio Company; April 14, 1948.

"Studio Facilities of KCRG/KCRK," by C. H. Stratemeyer, Collins Radio Company; April 14, 1948

CHICAGO

"Psychoacoustic Factors in Loudspeaker Selection," by H. S. Knowles, Jensen Manufacturing Company; March 19, 1948.

"Tone Poem with Color Slides," by F. Bemm; March 19, 1948.

"A New Look at the Audio Response Curve," by R. P. Glover, Consulting Engineer; March 19, 1948.

"Chicago IRE Conference; April 17, 1948."

CINCINNATI

"Television Conference," April 24, 1948.

"Preparedness During Peacetime," by J. L. Sullivan, United States Navy; April 26, 1948.

CLEVELAND

"Television Operation," by J. B. Epperson, Scripps-Howard Radio, Inc.; April 20, 1948.

COLUMBUS

"Cold Cathode Glow Discharge Tubes and their Circuit Applications," by W. Depp and W. H. T. Holden, Bell Telephone Laboratories; February 20, 1948.

"Electro Neurology," by M. M. Parker, College of Medicine, Ohio State University; March 12, 1948.

"F.M. Transmitter and Receiver Engineering Problems," by G. B. Saviers, Westinghouse Electric Manufacturing Company; April 9, 1948.

CONNECTICUT VALLEY

"Printed Circuits and Miniature Electronics," by C. Brunetti, National Bureau of Standards; May 13, 1948.

DALLAS-FORT WORTH

"Acoustical Considerations in Radio Broadcasting," by W. Rudmose, Southern Methodist Univefsity; April 29, 1948.

EMPORIUM

"A Thermionic Device with a Sense of Smell," by W. C. White, General Electric Company; May 6, 1948.

HOUSTON

"Microwave Radio Relay Systems," by M. G. Staton, Radio Corporation of America; April 21, 1948.

INDIANAPOLIS

"A Few Special Developments," by E. D. Cook, General Electric Company; April 23, 1948.

LOS ANGELES

"The Navy Electronics Laboratory," by R. Bennett, United States Navy; April 20, 1948.

"A Short Survey of Sonar Equipment and its Development," by R. O. Burns, United States Navy Electronics Laboratory; April 20, 1948.

"Model Studies of Communication Antennas and Facilities for Microwave Antenna Investigations," by V. C. Smith, United States Navy Electronics Laboratory; April 20, 1948.

LOUISVILLE

"152–162 Mc Urban Radio Telephone System," by S. H. Gates, Southern Bell Telephone and Telegraph Company; April 16, 1948.

MONTREAL

"Affairs and Aims of the I.R.E.," by B. E. Schackelford, President, The Institute of Radio Engineers; February 18, 1948.

NEW YORK

"Avenues of Improvement in Present-Day Television," by D. G. Fink, *Electronics;* May 5, 1948.

NORTH CAROLINA-VIRGINIA

"Measuring Devices for U.H.F. Transmission Lines," by W. M. Breazeale, University of Virginia; February 27, 1948.

"I.R.E. Affairs," by B. E. Shackelford, President, The Institute of Radio Engineers; April 9, 1948.

OTTAWA

"Some Engineering Problems Investigated by the Canadian Broadcasting Corporation Transmission and Development Department," by J. E. Hayes, Canadian Broadcasting Corporation; April 22, 1948.

Election of Officers; April 22, 1948.

PORTLAND

"Problems in Radar Indicators," by M. A. Starr, University of Portland; May 4, 1948.

SACRAMENTO

"The Institute of Radio Engineers," by F. E. Terman, Stanford University; April 20, 1948.

"A Zero to 200 Mc Amplifier Using Conventional Tubes," by J. Noe, Hewlett-Packard Company; April 20, 1948.

ST. LOUIS

"The Cyclotron," by F. N. D. Kurie, Washington University; April 22, 1948.

SAN DIEGO

"Future Electrical Applications of Structural Plastics," by G. G. Havens, Narmco Incorporated; April 6, 1948.

SAN FRANCISCO

"Radar and Microwaves," by J. O. Perrine, American Telephone and Telegraph Company; March 26, 1948.

SEATTLE

"A New Method of Analyzing Complex Waves," by W. E. Rogers, University of Washington; April 16, 1948.

SYRACUSE

Air Navigation and Traffic Control," by R. C. Jensen, H. F. Mayer, O. H. Winn, and J. W. Nelson, General Electric Company; May 6, 1948.

Election of Officers; May 6, 1948.

TOLEDO

"High-Quality Radio Program Links," by H. A. French, Federal Telecommunication Laboratories, Inc.; April 26, 1948.

TWIN CITIES

"Principles and Applications of Magnetic Recording," by R. Marchant, Minnesota Mining and Manufacturing Company; April 1, 1948.

WASHINGTON

"Communications Theory," by W. G. Tuller, Melpar, Inc.; April 12, 1948.

SUB-SECTIONS

FORT WAYNE

"Modern Recording Mechanism and Equipment," by B. Ratts, Radio Station WOWO; April April 30, 1948.

Election of Officers; April 30, 1948.

(Continued on page 35A)

SECTION MEETINGS

(Continued from page 34A)

LANCASTER

"Technical and Economical Aspects of Industrial H.F. Heating," by G. W. Scott, Jr., Armstrong Cork Company; April 14, 1948.

MOUNMOUTH

"Field Coverage Considerations of New York Television Stations and Interference Problems of Shared Channel Stations," by T. T. Goldsmith and R. Wakeman, Allen B. Dumont Laboratories; January 21, 1948.

"Basic Considerations in Design of Digital Computer and their Application of the Edvac," by S. Lubkin, Reeves Instrument Corporation; February 18, 1948.

"Solar and Cosmic Noise," by C. R. Burrows, Cornell University; April 21, 1948.

NORTHERN NEW JERSEY

"Pulse Code Modulation and the Electron Beam Coding Tube," by L. A. Meacham and R. W. Sears, Bell Telephone Laboratories; May 12, 1948.

Election of Officers; May 12, 1948.

STUDENT BRANCH MEETINGS

ALABAMA POLYTECHNIC INSTITUTE, I.R.E. BRANCH

"Uses of the Oscilloscope," by J. Montgomery, Alabama Polytechnic Institute; April 19, 1948.

"Demonstration in Short Radio Waves and Microwaves," by F. Allison, Alabama Polytechnic Institute; May 3, 1948.

UNIVERSITY OF ARKANSAS, I.R.E. BRANCH

"The Synchrodyne Receiver," by H. Cooke, Student, University of Arkansas; April 28, 1948.

UNIVERSITY OF CALIFORNIA, I.R.E.—A.I.E.E. BRANCH

"Applying Apparatus in Industry," by F. M. Roberts, General Electric Company; April 16, 1948.

UNIVERSITY OF ILLINOIS, I.R.E.—A.I.E.E. BRANCH

"The Part of the Engineer in Bettering Community Understanding," by F. A. Faville, Faville-Le Valley Corporation and Lincoln Engineering Company of Illinois; April 12, 1948.

KANSAS STATE COLLEGE, I.R.E. BRANCH

Election of Officers; April 22, 1948.

UNIVERSITY OF MICHIGAN, I.R.E.—A.I.E.E. BRANCH

"The Delray Plant," by G. A. Porter, Detroit Edison Company; April 15, 1948.

"Outlook for Engineers," by Mr. Le Clair, A.I.E.E.; April 15, 1948.

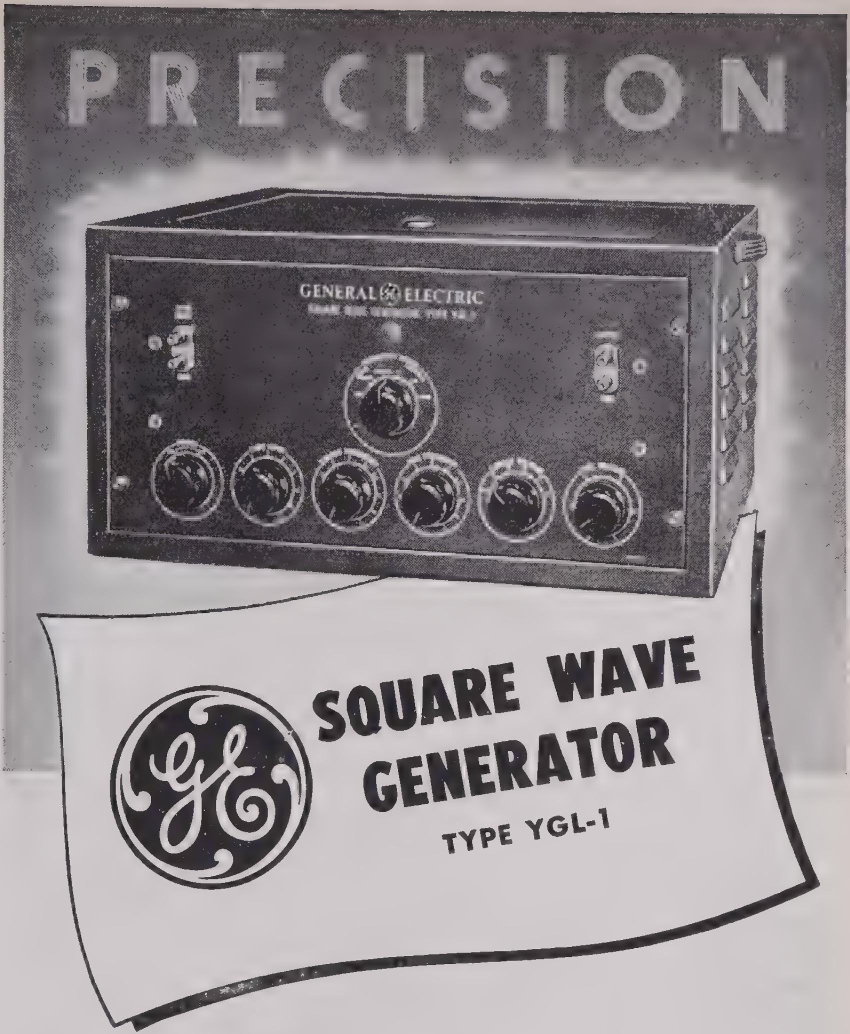
UNIVERSITY OF MINNESOTA, I.R.E.—A.I.E.E. BRANCH

"Licensing Engineers," by S. L. Stalte, Minnesota Association of Professional Engineers; March 16, 1948.

COLLEGE OF THE CITY OF NEW YORK, I.R.E. BRANCH

"The Design and Construction of an F.M. Receiver," by C. Fruchter, Student; April 13, 1948.

(Continued on page 36A)



DESIGNED to produce a square wave of excellent form, this equipment meets the rigid requirements of research and developmental laboratories, industry and educational institutions.

It has a wide fundamental frequency range, is highly stable and may be mounted either in a cabinet or rack.

PULSE CHARACTERISTIC: Rectangular wave output, with a 25% negative pulse.

RISE TIME: Approximately .3 microsecond.

FUNDAMENTAL FREQUENCY RANGE: Six overlapping ranges, to give continuous coverage from 5 to 125,000 cycles.

OUTPUT VOLTAGE: Variable from 0-5 volts; fixed outputs at 5, 10, 15, 25, 50 and 75 volts.

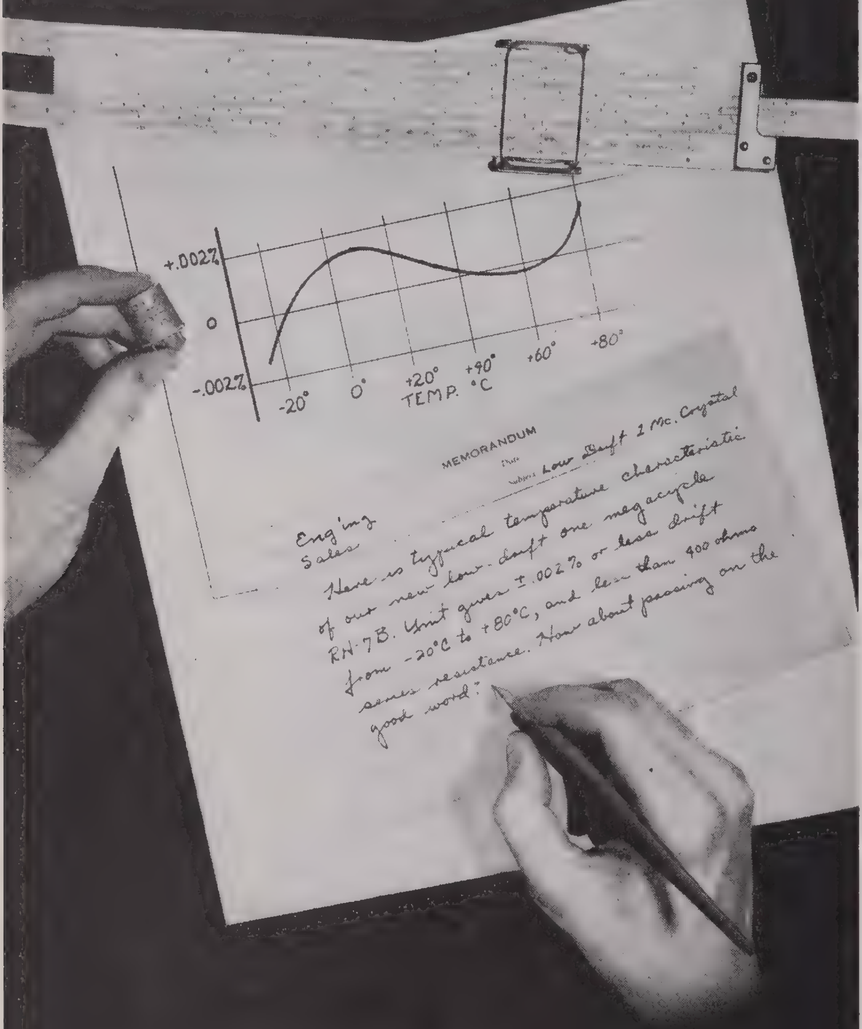
OUTPUT IMPEDANCE: 100 ohms at 5 volts, approximately 20 ohms/volts at all outputs.

SYNCHRONIZATION: A "sync" input level control is provided.

For complete information on this unit and other G-E Precision Equipments write: *General Electric Company, Electronics Park, Syracuse, New York.*

GENERAL ELECTRIC

A New
1-MC CRYSTAL



MEMORANDUM
Subject Low Drift 1 Mc. Crystal
Eng'ing
Sales
Here is typical temperature characteristic of our new low-drift one megacycle RH-7B. Unit gives ±.002% or less drift from -20°C to +80°C, and less than 400 ohms series resistance. How about passing on the good word?

Companion to the ±.005% wide range 1-mc crystal, the newest RH-7B can be produced at series resonance, 32 uufd, or to your specifications. Reeves-Hoffman engineers are equipped to work with you in planning your circuits.

For detailed specification write for Bulletin RHC-3

REEVES-HOFFMAN
CORPORATION
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STUDENT BRANCH MEETINGS

(Continued from page 35A)

"Trends in Television Receiver Design," by I. E. Lempert, Allen B. Dumont Laboratories; April 20, 1948.

"Facsimile," by L. R. Philpott, Finch Telecommunications; April 27, 1948.

"Vacuum Tubes," by F. W. Tietsworth, General Electric Company; April 29, 1948.

"Pulse Time Modulation," by S. Moskowitz, Federal Telecommunications Laboratories; May 4, 1948.

NORTH CAROLINA STATE COLLEGE, I.R.E. BRANCH

"Directional Antennas for Broadcasting," by B. E. Porter, Radio Station WNAO; April 14, 1948.

Election of Officers; April 28, 1948.

RUTGERS UNIVERSITY, I.R.E.—A.I.E.E. BRANCH

Election of Officers; May 5, 1948.

STANFORD UNIVERSITY, I.R.E.—A.I.E.E. BRANCH

"Demonstration of an Ampex Magnetic Tape Recorder," by H. W. Lindsay, Ampex Corporation; April 22, 1948.

SYRACUSE UNIVERSITY, I.R.E. BRANCH

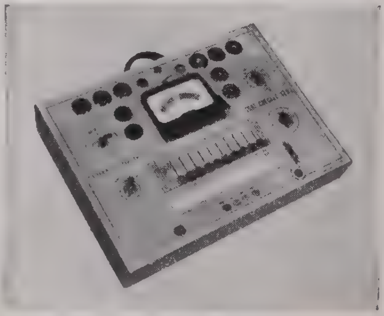
"The Professional Engineer," by J. B. Foley, Jr., J. B. Foley Inc.; April 21, 1948.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 24A)

New Tube Checker Eliminates Time Waste



A receiving-tube checker with a circuit designed to immediately expose a tube with an open filament without the usual warm-up period is being marketed by **G-E Specialty Div.,** Electronics Park, Syracuse, N. Y.

This checker, type YTW-1 completely portable and weighing only 15 lbs., has an individual circuit for each tube element. Operating from a standard a.c. power source, it tests 4-, 5-, 6-, 7-, and 8-pin standard, 5-pin small, 7- and 9-pin miniature and lock-in tubes, as well as pilot tubes and batteries.

(Continued on page 45A)

MEMBERSHIP

The following transfers and admissions were approved on June 2, 1948, to be effective July 1, 1948:

Transfer to Senior Member

Allen, H. C., 15 Rollingmead, Princeton, N. J.
Camras, M., 1313 S. Keeler Ave., Chicago 23, Ill.
Freeland, E. C., 111 Kirkwood Ave., Fox Chase Manor, Philadelphia 11, Pa.
Giacoletto, L. J., RCA Laboratories, Princeton, N. J.
Heberlein, A. A., c/o Bell Telephone Laboratories, Inc., 180 Varick St., New York 14, N. Y.
Jimenez-Michelena, L. G., 27 Ave., San Miguel, Caracas, Urbanizacion El Avila, Venezuela
Lakatos, E., RIE 433, Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Mabe, W. S., 42 Collindale Ave., Sidcup, Kent, England
Pote, A. J., 71 W. Squantum St., N. Quincy 71, Mass.
Segerstrom, C. A., 2 Maple Rd., Winchester, Mass.
Sink, R. L., 3119 Santa Anita, Altadena, Calif.
Stagnaro, J. A., 2207 Fairfield Ave., Fort Wayne 6, Ind.
Stokes, H. S., 425 N. Jackson St., Arlington, Va.
Trifari, F. R., 30 Maplewood Ave., Dobbs Ferry, N. Y.
Young, J. E., 114 Morris St., Merchantville, N. J.

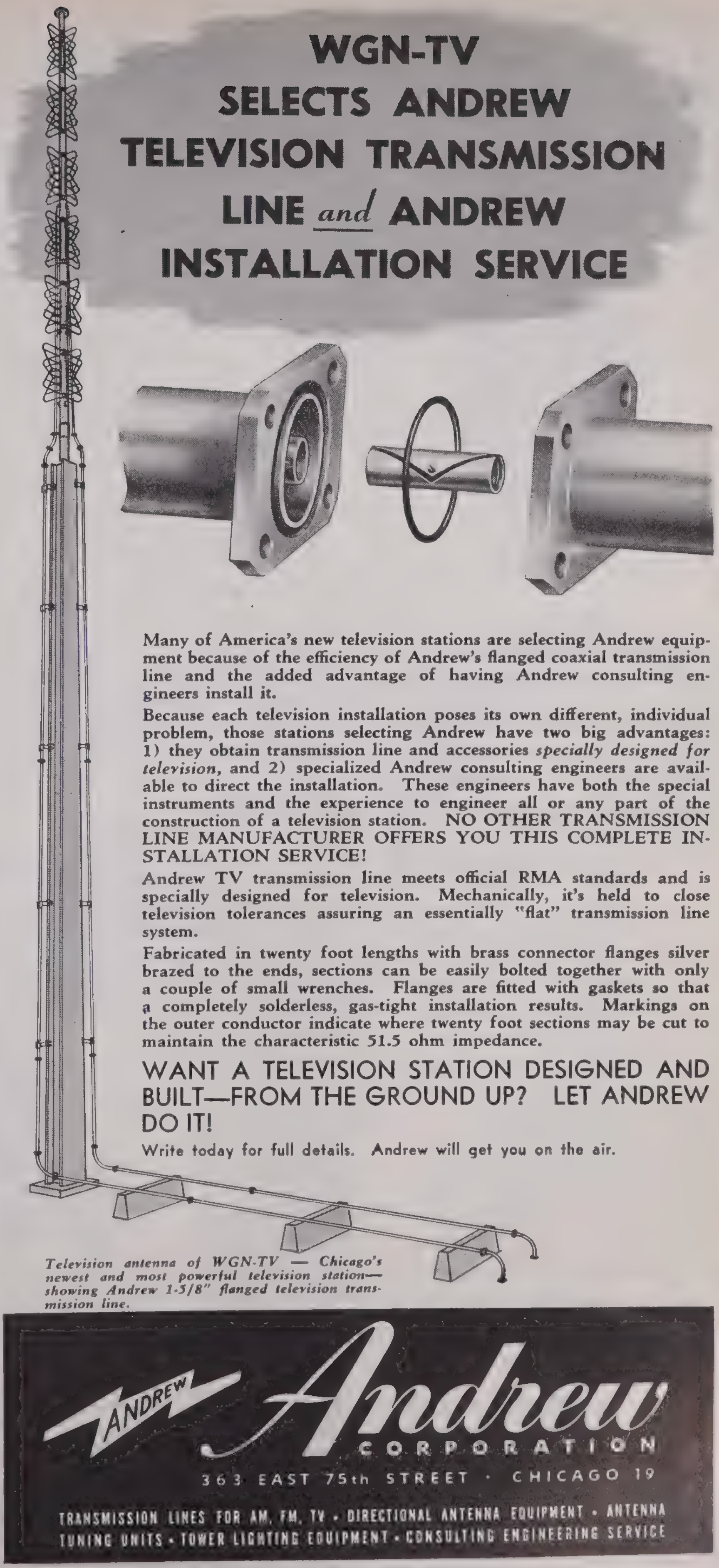
Admission to Senior Member

Apuli, J. A., 3100 Connecticut Ave., N.W., Washington, D. C.
Craigie, S. M., Tropical Radio Telegraph Co., Managua, Nicaragua
Dimock, P. V., 44 Beechwood Ave., Manhasset, N. Y.
Ellett, A., Zenith Radio Corp., 6001 W. Dickens Ave., Chicago 39, Ill.
Holden, W. H. T., 463 West St., New York 14, N. Y.
Hupert, J. J., 943 Monroe Ave., River Forest, Ill.
Ingles, H. C., 66 Broad St., New York 4, N. Y.
Lacy, L. Y., 52 Maple Ave., Madison, N. J.
Nash, P. E., 4865-A S. 28 St., Fairlington, Va.
Sinnett, C. M., 103 Virginia Ave., Westmont, N. J.

Transfer to Member Grade

Barbour, C. W., Jr., 52C Oak Grove Dr., Baltimore 20, Md.
Buccicone, V. S., 580 Taney Place, Gary, Ind.
Cacheris, J. C., 2701 14 St., N.W., Washington 9, D. C.
Cheng, D. K., Rm. 515, 111 Broadway, New York 6, N. Y.
Friedman, H., 35 Emmet St., Dayton, Ohio
Gehres, F. A., 2232 E. Powell, Evansville 14, Ind.
Gershon, J. J., 2475 Gunnison St., Chicago 25, Ill.
Groeteke, E. A., 4655 Elmbank, St. Louis 15, Mo.
Hemman, R. J. E., 231 Westerly Pkwy., State College, Pa.
Hornberger, J. E., Wertz Engineering Co., 30 N. Eighth St., Reading, Pa.
Mandell, A., 202 Highland Ave., Somerville 43, Mass.
Morgan, R. B., Sandia Base Branch, Albuquerque, N. Mex.
Murray, D. A., F.C.C., 208 Uptown Post Office Bldg., St. Paul 2, Minn.
Oberle, E. J., 1805 Main St., Jacksonville, Fla.
Richards, J. A. K., 1134½ S. Doheny Dr., Los Angeles 35, Calif.
Rohner, G. J., 10 Robley Evans Apt., Sampson College Fac., Sampson, N. Y.
Schulz, H. R., 531 E. Lincoln Ave., Mount Vernon, N. Y.
Silvester, D. D., 8 Carlos St., Godalming, Surrey, England
Sullivan, J. R., Communication Dept. Panagra, Limatambo, Lima, Peru, S. A.
Swanson, E. R., 5827 Madden Ave., Los Angeles 43, Calif.

(Continued on page 38A)



WGN-TV SELECTS ANDREW TELEVISION TRANSMISSION LINE *and* ANDREW INSTALLATION SERVICE

Many of America's new television stations are selecting Andrew equipment because of the efficiency of Andrew's flanged coaxial transmission line and the added advantage of having Andrew consulting engineers install it.

Because each television installation poses its own different, individual problem, those stations selecting Andrew have two big advantages: 1) they obtain transmission line and accessories *specially designed for television*, and 2) specialized Andrew consulting engineers are available to direct the installation. These engineers have both the special instruments and the experience to engineer all or any part of the construction of a television station. NO OTHER TRANSMISSION LINE MANUFACTURER OFFERS YOU THIS COMPLETE INSTALLATION SERVICE!

Andrew TV transmission line meets official RMA standards and is specially designed for television. Mechanically, it's held to close television tolerances assuring an essentially "flat" transmission line system.

Fabricated in twenty foot lengths with brass connector flanges silver brazed to the ends, sections can be easily bolted together with only a couple of small wrenches. Flanges are fitted with gaskets so that a completely solderless, gas-tight installation results. Markings on the outer conductor indicate where twenty foot sections may be cut to maintain the characteristic 51.5 ohm impedance.

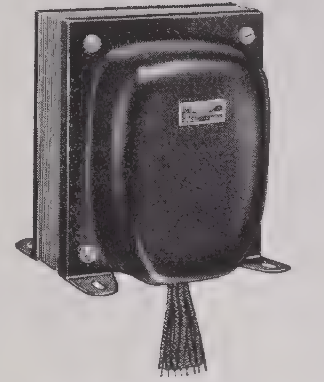
WANT A TELEVISION STATION DESIGNED AND BUILT—FROM THE GROUND UP? LET ANDREW DO IT!

Write today for full details. Andrew will get you on the air.

Television antenna of WGN-TV — Chicago's newest and most powerful television station—showing Andrew 1-5/8" flanged television transmission line.

ANDREW
Andrew CORPORATION
363 EAST 75th STREET · CHICAGO 19
TRANSMISSION LINES FOR AM, FM, TV · DIRECTIONAL ANTENNA EQUIPMENT · ANTENNA TUNING UNITS · TOWER LIGHTING EQUIPMENT · CONSULTING ENGINEERING SERVICE

TELEVISION TRANSFORMERS



for BETTER VIDEO REPRODUCTION

Acme Electric engineers will cooperate with your engineering department by providing specially designed transformers for power supply and other applications in an effort to improve the reception and reproduction qualities of your sets.

Acme Electric can produce transformers of special characteristics from standard parts which means that our enormous manufacturing facilities and quality controlled production results in buying economies for you.

Send us specifications and application outline.

ACME ELECTRIC CORP.
447 WATER ST, CUBA, N.Y.

Acme Electric TRANSFORMERS

MEMBERSHIP

(Continued from page 37A)

Swingle, D. M., 70 Jarvis Ct., Cambridge 38, Mass.
Torian, R. B., 430 S. Elm Dr., Beverly Hills, Calif.
Trego, D. G., 949 Wye Dr., Akron 3, Ohio
Turner, F. T., Box 114, Hampton Bays, N. Y.
Wigington, L. M., 317 W. Third St., Morrestown, N. J.
Wood, K. P., 104 Bramshot Ave., London, S.E.7, England

Admission to Member Grade

Burke, A. C., 63 Yorkville Ave., Toronto, Ont., Canada
Butterfield, F. E., Andrew Corp., 363 E. 75 St., Chicago, Ill.
Chapel, I. J., 916 Southern Blvd., New York 59, N. Y.
Cohen, J., 2420 14 St., N.E., Washington 18, D. C.
Davis, C. W., Marine Sales Department, Sperry Gyroscope Co., Great Neck, L. I., N. Y.
Fink, L., III, Rm. 210, 1401 Arch St., Philadelphia 2, Pa.
Fraser, G. R., 118 Irvington St., S.W., Apt. 2A, Washington 20, D. C.
Hall, I. A., Jr., 191 Duncan Dr., Assinippi, Mass.
Haurlan, P. N., Electronics Institute, Inc., 21 Henry St., Detroit 1, Mich.
Hauser, A. A., Jr., Sperry Gyroscope Co., Mail Station K-39, Great Neck, L. I., N. Y.
Havelka, G., 284 Pod Klaudiankou, Praha-Podoli, Czechoslovakia
Hotine, W., 10 Bromley Lane, Great Neck, L. I., N. Y.
Huckabee, J. R., Box 1679, Houston 1, Tex.
John, A. G., Indian Students Union and Hostel, 112 Gower St., London, W.C.1, England
Luddy, E. N., 311 E. 13 St., Amarillo, Tex.
Marsh, G. E., 1109 E. Harvey, Fort Worth, Tex.
Massey, M. M., 1124 Vermont Ave., N.W., Washington 5, D. C.
McCauley, C., Jr., R.F.D. 1, Winston-Salem, N. C.
Murtaugh, W. A., Providence College, Providence 8, R. I.
Nolte, R. E., 263 Campus, Ames, Iowa
Pakan, J. J., 238 N. Pine Ave., Chicago 44, Ill.
Parlas, J. L., 218 N. Globe Rd., Arlington, Va.
Perron, R. R., 35 Broadway, Beverly, Mass.
Pierce, C. H., TWA, 400 E. Donovan Rd., Kansas City, Kan.
Plummer, J. W., Tactical Test, NATC, Patuxent River, Md.
Rosmovsky, P., 108 Second Ave., Bradley Beach, N. J.
Sadler, J. T., 42 Huntington Rd., Garden City, N. Y.
Schifino, A. G., 80 Thurston Rd., Rochester 11, N. Y.
Schwennesen, A. B., 4235 Merrimac Ave., Dayton 5, Ohio
Shaw, J. E., c/o Western Electric Co., 120 Broadway, New York 5, N. Y.
Smith, G. B., 3806 N. Broadway, Knoxville 18, Tenn.
Sronce, G. S., 3571 23 St., Sacramento, Calif.
Stanton, J. S., 1804 Watervliet Ave., Dayton 10, Ohio
Vazaca, C. S., 10 Berzei, Bucharest, Roumania
Warren, J. E., 8 Ruby Place, Newark 4, N. J.

The following admissions to Associate Grade have been approved and will be effective as of June 1, 1948:

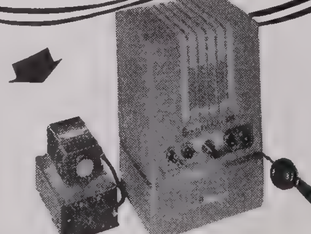
Acunto, V. S., 2430 Atlantic Ave., Brooklyn 33, N. Y.
Auerbach, B., 340 Carteret St., Camden, N. J.
Bartels, W. S., Electronics Test, NATC, Patuxent River, Md.
Berger, Mrs. J. M., 1741 Andrews Ave., New York 53, N. Y.

(Continued on page 39A)

"A Well Known Name in Radio for Over 25 Years"

NO. 7 OF A SERIES

Carter
Preferred Power for HARVEY WELLS Marine Radio Telephone



Where life or death may depend on *reliable* communications, the Carter Genemotor is the logical power supply. That's why Harvey-Wells picks Carter to power the marine transmitter shown here. At the flick of a switch... in less than 3/10 of a second; the Carter Genemotor supplies full power...dependable power...designed to provide for thousands of service-free radio transmissions.

Carter Motor Co.
Chicago, Illinois

2645 N. MAPLEWOOD AVENUE • CABLE: GENEMOTOR

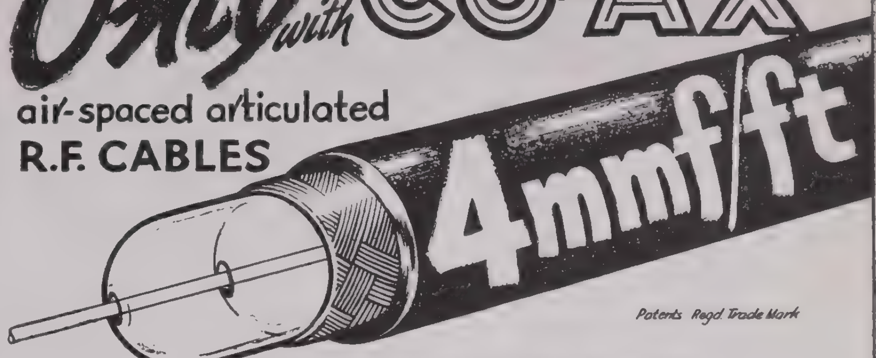
MEMBERSHIP

(Continued from page 38A)

Birchmeier, C. E., 7 Handley Ave., Bexley North, New South Wales, Australia
Bramsen, E. A., 3737 14 Ave. S., Minneapolis 7, Minn.
Bukofzer, R., 39-48—65 St., Woodside, L. I., N. Y.
Ceccarini, R. E., 325 S. Bedford Dr., Beverly Hills, Calif.
Chase, R. L., 2121 Beekman Place, Brooklyn 25, N. Y.
Cipolla, A. H., 40-13—69 St., Woodside, L. I., N. Y.
Cullen, J. G., 340 S. Third St., Baton, N. Mex.
Deeken, J. W., 556 Telford Ave., Dayton 9, Ohio
Docca, S. N., c/o Dr. G. Vinayake Rao, 4, Sripuram II St., Royapettah, Madras, India
Fernandez Acquier, A. H., Bme. Mitre 1961, Buenos Aires, Argentina
Fisher, E. H., 6536 Aylesboro Ave., Pittsburgh 17, Pa.
Geisler, H. J., Court H. Apt. 40-C, Stadium Ter., Champaign, Ill.
Gopalakrishna, T. V., Tadinada Bldgs., Rajahmundry, Madras, S. India
Hare, J., 48, Cochrane Park Ave., Newcastle-on-Tyne, 7, England
Hyland, F. G., 2125 Darwin Ave., Los Angeles 31, Calif.
Johnson, A. H., 219 Milford Dr. W., Syracuse 6, N. Y.
Jones, R. B., 4919 Behrwald Ave., Cleveland 9, Ohio
Kenny, J. A., 43-17—220 Place, Bayside, L. I., N. Y.
Klein, S., 4909 N. 17 St., Philadelphia 41, Pa.
Komenko, J. W., 210 Schenck Ave., Brooklyn 7, N. Y.
Lanciani, D. A., 22 Baxter Ter., West Medford 55, Mass.
Levens, P. J., 1505 Ocean Ave., Brooklyn 30, N. Y.
Lucas, F. P., 8796 Petoskey Ave., Detroit 4, Mich.
Macropulos, G. S., 7306 S. Green St., Chicago 21, Ill.
Matarazzo, T., Jr., 11 Marshfield St., Roxbury 19, Mass.
McMurray, C. R. 2902 Jennings Rd. Kensington, Md.
McQuiston, W. R., Box 312, Boeing Airplane Co., Alamogordo, N. Mex.
Melton, D. P., 1023 Gardenia Dr., Houston 8, Tex.
Mulgan, D. K., York Bay, Wellington, New Zealand
Nagel, R. F., Cyclotron Laboratories, Washington University, St. Louis, Mo.
Reeves, C. A., Sr., 1323 Schley Ave., San Antonio 3, Tex.
Reisenweaver, W. B., General Delivery, Kernersville, N. C.
Schnell, W. S., 3650 Rugby Dr., Toledo 9, Ohio
Schuh, L., 1253 Loyola Ave., Chicago 26, Ill.
Silson, R. G., The Schoolhouse, Fosdyke, Boston, Lincs., England
Stone, R. S., 6037 W. Addison St., Chicago 34, Ill.
Striplin, J. E., 2713 W. 154 St., Gardena, Calif.
Strobach, F., 106 Myrtle St., Suite 9, Boston 14, Mass.
Swontek, W. J., 5917 Storer Ave., Cleveland 2, Ohio
Taherzadeh, A., c/o Mr. Bridge, General Electric Company of England, Telephon Wks., Coventry, England
Taschler, F., 527 E. 88 St., New York 28, N. Y.
Velkers, G. D., Box 1365, AA & G.M. Branch, TAS, Fort Bliss, Tex.
Wagner, F. C., 2116 Portland Ave. S., Minneapolis 4, Minn.
Wagner, T. C. G., 4995 Newport Ave., Washington 16, D. C.
Walker, G. A., Sr., 14560 Sherman Cir., Van Nuys, Calif.
Whittenberg, H. H., 7115 Casa Loma, Dallas, Tex.
Yu, Y. P., Electrical Engineering Department, North Dakota Agricultural College, Fargo, N. Dak.

Only with CO-AX

air-spaced articulated
R.F. CABLES



Patents Regd. Trade Mark

THE LOWEST EVER CAPACITANCE OR ATTENUATION

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We are specially organised to handle direct enquiries from overseas and can give

IMMEDIATE DELIVERIES FOR EXPORT

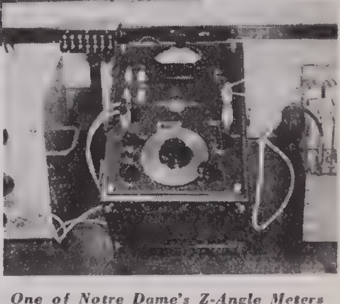
Write or cable for data sheets or deliveries to the Originators of flexible air-spaced R.F. Cables

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD·LONDON SW.7 ENGLAND
CABLES: TRANSRAD. LONDON.

LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft of 100 Mc/s.	LOADING Kw	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	HIGH POWER FLEXIBLE
A 34	73	0.6	1.5	0.88	
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C 33	4.8	220	2.4	0.64	V.L.C. ★
C 44	4.1	252	2.1	1.03	

★ Very Low Capacitance cable

Engineering Building, University of Notre Dame



One of Notre Dame's Z-Angle Meters

Student Laboratory Measurements at NOTRE DAME with Z-ANGLE METERS

Dr. H. E. Ellithorn, Associate Professor of Electrical Engineering at the University of Notre Dame has this to say about the Z-Angle Meter:

"The Z-Angle Meters have been in use at Notre Dame for the past four months with great success. The meters have been used to find the open circuit and short circuit impedances of artificial lines and cables; clamped and unclamped impedances of telephone receivers; impedances of two terminal balancing networks as a function of frequency and other impedance tests."

"In the case of the artificial lines and cables, the time necessary to obtain the measurements was reduced to one-half that usually required by ordinary bridge methods."

Write today for Bulletins on the Z-Angle Meter, R-F Z-Angle Meter, R-F Oscillator and Precision Variable Resistors.

TECHNOLOGY INSTRUMENT CORP.
1058 MAIN STREET, WALTHAM 54, MASS.

Midwest Office: Alfred Crossley & Associates, 549 W. Randolph St., Chicago 6, Illinois, State 7444

WANTED
ELECTRONIC ENGINEERS
AND PHYSICISTS

Excellent opportunities for graduates with research, design, and/or development experience in Communications and aerial navigation systems including direction finders, radar, FM, television, micro-wave.

Write complete details regarding education, experience and salary desired.

To personnel manager
Federal Telecommunication Laboratories
500 Washington Ave.
Nutley, New Jersey

Positions Open for

PHYSICISTS
SENIOR ELECTRONIC ENGINEERS
SENIOR MECHANICAL ENGINEER
CHEMIST FOR PROBLEMS ASSOCIATED WITH TUBE DEVELOPMENT

Experienced in radar development, servomechanisms and computers to fulfill the requirements of an expanding airborne radar project, research in electron optics and tubes, and production engineering.

Salary commensurate with experience and ability—insurance plan—paid vacations—excellent opportunity for suitably qualified personnel.

Please furnish complete resume of education, experience and salary required to:

Industrial Relations & Personnel Department, Farnsworth Television & Radio Corporation, Fort Wayne 1, Indiana

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
I East 79th St., New York 21, N.Y.

ENGINEERS—PHYSICISTS

The Aeronautical Research Center of the University of Michigan at Willow Run, Michigan, has several openings for engineers and physicists with experience in the fields of servo-mechanisms, electronics and instrumentation. Interested applicants should furnish complete outline of experience with letter of application. University of Michigan, Personnel Office, 208 University Hall, Ann Arbor, Michigan.

TECHNICAL RADIO ENGINEER

Radio engineer, capable of adjusting (or learning) complex directional antennas, for positions with Washington consultant. State detailed qualifications, education and salary requirements. Box 514.

ELECTROLYTIC CAPACITOR ENGINEER

Exceptional opportunity for right man who can qualify for development engineering post with leading manufacturer. Please send complete particulars in first letter. Our men know of this advertisement. Reply Box 515.

TELEVISION ENGINEER

Chief engineer of television broadcast station located in midwest city. Please state fully experience and qualifications. Box 516.

RADIO RECEIVERS ENGINEER

Radio receiver engineers. Various types of qualifications. Please state experience and salary requirements in first letter. Box 517.

ENGINEERS

Allen B. DuMont Laboratories, Inc., have several openings in their Clifton plant for intermediate and senior engineers. Must have B.S. degree in physics of electrical engineering and experience in V.H.F., television deflection or general circuit development. Apply personnel Dept., 1000 Main Ave., Clifton, New Jersey. 9:00 A.M. to 3:00 P.M.

ELECTRONIC DESIGN ENGINEER—PRODUCTION ENGINEER

(1) ELECTRONIC DESIGN ENGINEER—Boston firm developing electronic instruments for radioactivity detection and measurement. Offers excellent opportunity for high calibre design engineer. Write full details.

(2) PRODUCTION ENGINEER—Boston firm manufacturing electronic radioactivity instruments has opening for qualified man experienced in engineering production models from prototype designs. Position also entails responsibility for component and production quality control. Write full details. Box 518.

(Continued on page 42A)

WANTED
PHYSICISTS
ENGINEERS

Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or development experience on radio communications systems, Servomechanisms (closed loop), electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.

WRITE FULL DETAILS
TO
EMPLOYMENT SECTION

SPERRY GYROSCOPE
COMPANY
DIVISION OF SPERRY CORP.
Marcus Ave. & Lakeville Rd.
Lake Success, L.I.

ENGINEERS – ELECTRONIC

Senior and Junior, outstanding opportunity, progressive company. Forward complete résumés giving education, experience and salary requirements to

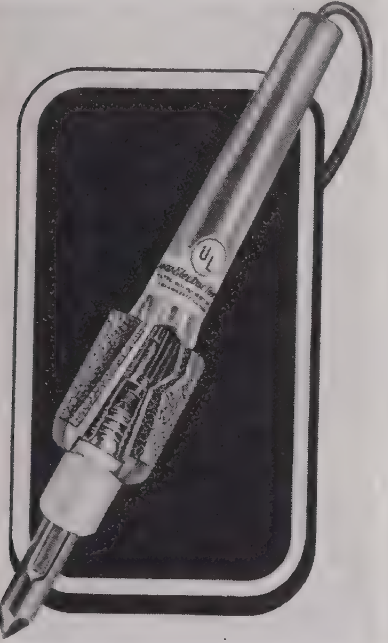
Personnel Department
MELPAR, INC.
452 Swann Avenue
Alexandria, Virginia

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 36A)

Soldering Pencil for Difficult and Inaccessible Places

An improved pencil soldering iron that is said to assure tightness and guarantee contact by use of a spring-action rivet that takes up expansion has been announced by **Ungar Electric Tool Co.,** Los Angeles 54, Calif.



The element is rated at 20 watts and has been tested at 1000 hours operation. It operates on 110–120-volt a.c.-d.c.

The complete product has four interchangeable Tellurium tips: $\frac{1}{8}$" pencil, $\frac{1}{8}$" and $\frac{5}{8}$" chisel, and $\frac{3}{8}$" pyramid. Copper tip length beyond the heating coil is $\frac{5}{8}$" on the $\frac{3}{8}$" tips, and $\frac{7}{8}$" on the $\frac{1}{8}$" tips. Both heat to 600° in 90 seconds.

1000 Watt "Ham" Transmitter for the U.N. at Lake Success

The United Nations station, known as K2UN, will have two transmitters of 1000 watts each. One operates on the 80 and 40 meter bands, and covers a good part of the U. S. from the transmission point at Lake Success. The other broadcasts in the high ends of the 20 and 10 meter phone bands and is capable of making contact with amateur operators all over the world.

At the outset the frequency of broadcasts will be uncertain, but it is hoped ultimately to arrange daily contacts on a world wide basis from 4:00 PM to midnight.

The station was opened May 17, with George W. Bailey, W2KH, sending out the first call in his capacity as president of the International Amateur Radio Union.

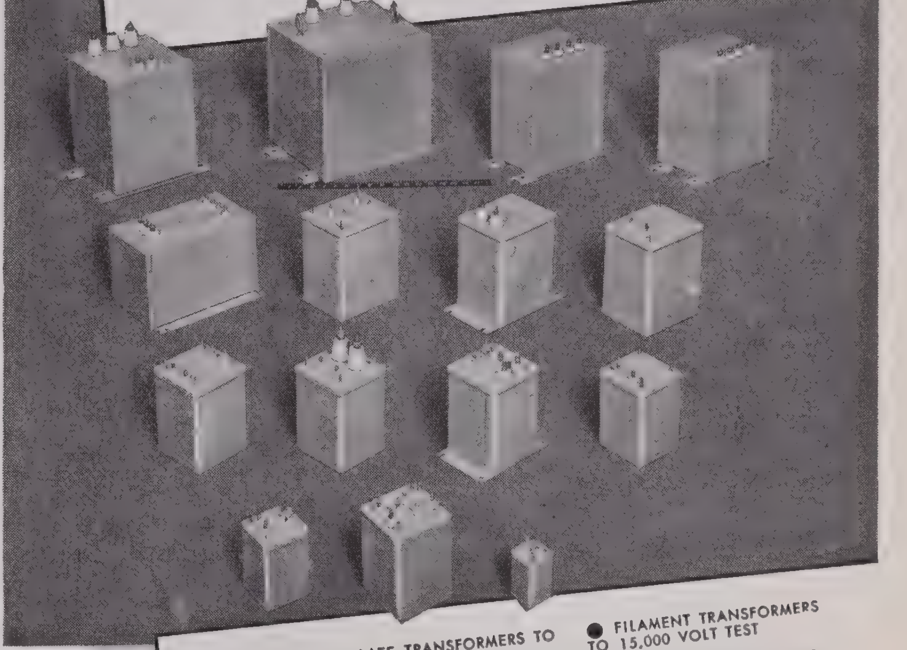
(Continued on page 47A)

New! All inclusive!

N Y T

STANDARD LINE OF TRANSMITTER COMPONENTS

FOR AM, FM AND TV—LABORATORY AND INDUSTRIAL APPLICATIONS



INCLUDING—

- PLATE TRANSFORMERS TO 10 KVA
- FILTER REACTORS
- FILAMENT TRANSFORMERS TO 15,000 VOLT TEST
- PLATE FILAMENT TRANSFORMERS LOW VOLTAGE

FEATURING—

- 115/230 VOLT, 50/60 CYCLE SUPPLY
- RUGGED INTERNAL CONSTRUCTION, SUPPORTED CORE STRUCTURE
- EYE BOLTS ON LARGE UNITS FOR EASY HANDLING
- AIEE SURGE TEST ON HIGH VOLTAGE UNITS
- EFFICIENT MAGNETIC AND ELECTRO-STATIC SHIELDING
- UNIFORM STREAMLINED APPEARANCE
- STURDY STEEL CASES

Here is one of the finest and most complete lines of standard transmitter components available today. Built to the same well-known high standards as N·Y·T custom-built units, they bring to the design engineer the full economy of standardized construction. Superbly constructed, inside and out, each unit fully reflects the years of experience that have made the name NEW YORK TRANSFORMER synonymous with quality, integrity and dependability wherever inductive components are used.

WRITE FOR CATALOG

NEW YORK TRANSFORMER CO., INC.
ALPHA, NEW JERSEY

EDM
METERS

HAVE YOU A METER PROBLEM?

Electric Design & Manufacturing Corporation takes pride in being able to produce at modest cost custom engineered meters to meet your specific needs.

We particularly specialize in instruments involving unusual resistance and damping requirements. Because of our precision methods, we are able to produce instruments with extremely high sensitivity and low resistance—without sacrificing durability or ruggedness.

Our craftsmen utilize the most modern production methods and machines to speed production yet keep costs at a minimum.

Only the finest of materials are used and all EDM Meters are subjected to rigid double inspection before being shipped.

MILLIAMPERES
DC
2
4
6
8

If you have a meter problem, why not contact us? You'll be agreeably surprised to discover that we can give you what you want, when you want it and at very reasonable cost.

EDM
ELECTRIC DESIGN & MFG. CORP.
BURLINGTON, IOWA

1500 VOLT POWER SUPPLY

POWER SUPPLY
FURST
ELECTRONICS
POWER

Continuously Adjustable and Regulated 600-1500 V.D.C. at 0-1 Milliampere.

For Use With Geiger Counters, Photo multiplier Tubes, Cathode Ray Tubes and Other Applications Requiring High Voltage at Low Current.

Regulation: Output Voltage varies less than .01% of output voltage per volt change of line voltage and less than 1 Volt with variations of output current between 0-1 Milliampere. (Internal impedance less than 1000 Ohms)

MODEL 710-S
Cabinet Mounted—$160.00
Net F.O.B. Chicago

MODEL 710-SR
With Standard Rock Mounting—$165.00
Net F.O.B. Chicago

Also available in 2 or 3 independently regulated and independently adjustable outputs.

FURST ELECTRONICS
806 W. North Ave., Chicago 22, Illinois

Positions Wanted

(Continued from page 44A)

ELECTRICAL ENGINEER

Electrical Engineer. Age 27. Single. B.E.E. 1949. 5 years experience in testing, development, drafting and maintenance of electrical equipment. Wants New York sales position with electrical or electronic equipment manufacturing company. Sales training must be part of long term program. Write Box 145W.

ELECTRICAL ENGINEER

B.E.E. 1943 C.C.N.Y., M.S. 1948 Columbia University. Age 27. Married. Six years experience on electronic research, product engineering and instructing including one year AAF service. Available June 1948. Prefer Omaha, Nebraska, or New York. Box 146W.

JUNIOR ENGINEER

School: RCA Institutes Inc., N.Y.C. 1948 Ex-Petty Officer Telegraphis (Royal Canadian Navy). Married. No children. Experience: Radio assembly. Operation, maintenance and installation of receivers, transmitters (LF, UHF), radar, RDF (LF, VHF) loran. Interested in engineering and sales. Box 147W.

ELECTRICAL ENGINEER

B.E.E., R.P.I. (Communications). Age 26. Married. 1 child. Two years Navy maintenance of radio and radar equipment. One year Civil Service testing VHF-UHF transceivers. Current development of signal generators. Desires position as sales engineer. Box 148W.

ADMINISTRATIVE ENGINEER

Registered electrical engineer (N.Y.) FCC licenses. Eight years experience in engineering, production, construction and administration; with power communications and aircraft organizations. Harvard Business School graduate. Navy radar trained veteran. West coast preferred. Box 149W.

ELECTRICAL ENGINEER

B.S.E.E. Columbia June 1948. Age 29. Married. 2½ years Naval radar; 1 year Naval Research Lab., 1½ years instructor in theory and shop practice; 5 years experience in production planning and coordinator-metal and woodworking manufacturing. Tau Beta Pi. Desires position in design, development or production anywhere in the U.S.A. Box 150W.

TELEVISION ENGINEER

B.E.E. Cooper Union. Age 25. Single. 3½ years experience in development and design of U. S. Navy Airborne I.F.F. and airborne television receivers, F.M. radar system, civilian television receivers. Also maintenance and operation of radar sets in Army Ground Forces. Desires position in design of electronic equipment; New York City vicinity or northeast. Box 160W.

(Continued on page 48A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 45A)

New Enterprises and New Locations

• • •On April 1, **Electrical Reactance Corp.,** of Franklinville, N. Y., announced the opening of a Canadian plant at Prescott, Ont., Canada.

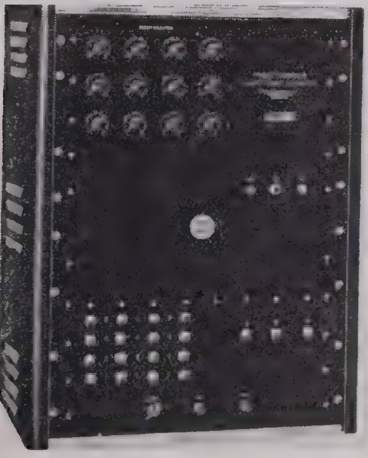
Under the direction of T. G. Kincaid this division will manufacture capacitors, resistors, and choke coils, but orders will have to be placed through the N. Y. address.

• • •On May 1, **Standard Arcturus Corp.** moved to its new address at 54 Clark St., Newark, N. J. Now located at this new plant are Arcturus Radio & Television Corp., Kotron Rectifier Corp., and Arcturus Electronics Inc., Tube Division.

• • •On May 13, the War Assets Administration approved the purchase of the Wright Aeronautical Corporation plant at East Paterson, N. J., by **Allen B. DuMont, Labs., Inc.,** for $1,700,000.

• • •On May 15, **Presto Recording Corp.** moved to its new consolidated plant at Paramus, N. J., located seven miles from New York City on Route 4, via George Washington Bridge. Address mail to P.O. Box 500, Hackensack, N. J.

Three-Sequence Predetermined Electronic Counter

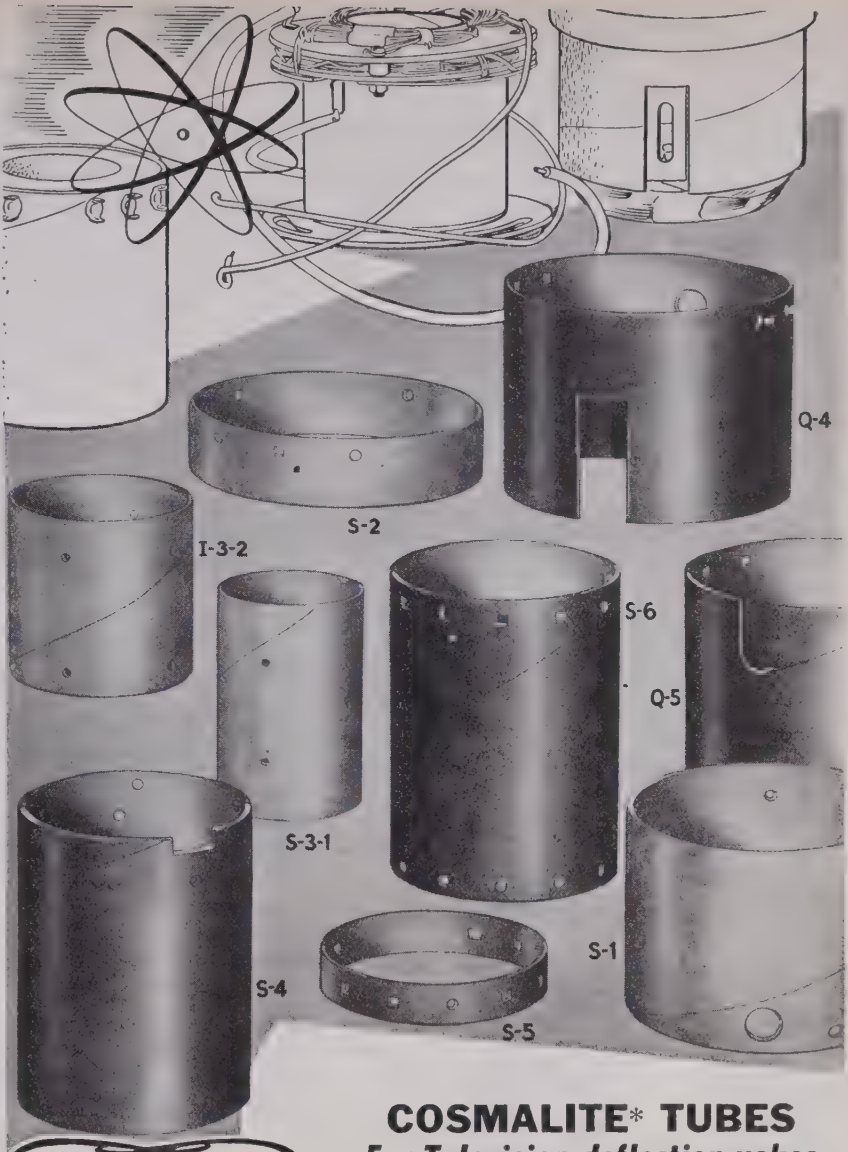


As an extension of the single and dual types, this product will predetermine three different counts that occur in sequence, each of which can be any number from 1 to 10,000.

Developed by the **Potter Instrument Co., Inc.,** 136–56 Roosevelt Ave., Flushing, N. Y. it uses four-tube counter decades which are completely electronic and have no moving parts. The input consists of three high-speed mercury-type relays, each of which is energized at the completion of its associated count.

Although the multiple-sequence counters are usually designed for counting speeds up to 15,000 per minute, higher rates will be supplied from this company on order.

(Continued on page 48A)



COSMALITE* TUBES

For Television deflection yokes

	Inside Diameter	Length
DEFLECTION YOKE SHELLS		
S-1	3"	2 5/16"
S-4	2 3/8"	3 7/16"
Q-3	3"	2 31/32"
Q-4	3"	2 11/32"
Q-5	3"	2 11/32"
S-6	2 3/8"	3 7/16"
DEFLECTION YOKE CORES		
S-3-1	1 33/64"	2 15/32"
S-3-2	1 33/64"	2 11/32"
S-3-3	1 33/64"	2 19/32"
I-3-1	1 17/32"	2 3/8"
I-3-2	1 7/8"	2"
DEFLECTION YOKE RINGS		
S-2	3"	3/4"
S-5	2 3/8"	15/32"

* Trade Mark Registered

These spirally laminated paper base, phenolic tubes are obtainable in sizes and with punching and notching that meet each customer's individual needs.

Quality performance at prices that appeal.

OTHER COSMALITE TYPES INCLUDE . . .

#96 Cosmalite for coil forms in all standard broadcast receiving sets. SLF Cosmalite for Permeability Tuners. Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

Partial List of Radio & Television Receivers in which COSMALITE is used:

Admiral
Arvin
Belmont
Bendix Radio
Colonial
Farnsworth
General Electric
Howard
Magnavox
Motorola
Sentinel
Stewart Warner
Warwick
Wells Gardner
Zenith

Inquiries given specialized attention.

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

- All-Fibre Cans • Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

★ ★ ★

PRODUCTION PLANTS also at Plymouth, Wisc., Ogdensburg, N.Y., Chicago, Ill., Detroit, Mich., Jamesburg, N.J.
PLASTICS DIVISION at Plymouth, Wisc. • ABRASIVE DIVISION at Cleveland, Ohio
SALES OFFICES: Room 5632, Grand Central Term. Bldg., New York 17, N.Y., also 647 Main St., Hartford, Conn.
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario

Engineers... like to SHOP at 'NEWARK'

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RADIO and ELECTRONIC
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RECORDERS
TELEVISION SETS
TUBES
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TRANSMITTING and RECEIVING EQUIPMENT

For all your personal or professional needs in Radio and Electronic equipment — save time, save MONEY, by shopping 'Newark' FIRST!

Engineers, who "live by the clock" have learned to depend on Newark's speedy, efficient service . . . our high geared organization of technically trained personnel know how important YOUR order is to YOU . . . mail and phone orders shipped same day! All standard makes of Tubes, Components, Receiving, Transmitting, Public Address, and Recording Equipment, in stock.

WIRE & TAPE RECORDERS — all makes now on demonstration at any of our THREE GREAT STORES, centrally located in New York and Chicago.

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ELECTRIC COMPANY, INC.

CHICAGO
323 W. Madison St.
Chicago 6, Ill.

New York City Stores: 115-17 W. 45th St. & 212 Fulton St.

Positions Wanted

(Continued from page 46A)

ENGINEER

B.E.E. (R.P.I., 1941) LL.B. (Brooklyn Law School, 1948). 5 years product and research engineering in electronic servo-control systems. Ex-engineering officer. Seeking position in patents, legal department or as junior executive, FCC radio telegraph, 1st class, 10 years. Write Box 161W.

ENGINEER

Engineer B.S. in E.E., M.S. in Ae.E. 4½ years experience in development, test and manufacturing of automatic flight control systems for conventional aircraft and guided missiles Desires position in New York City area. Available in June. Box 162W.

ELECTRONIC ENGINEER

B.S.E.E. Northeastern University, Boston, 1947. Two years experience as Navy radio technician with Navy radar and communications equipment. Some experience in sonar equipment design at Naval Research Lab., Washington, D.C. Hold 1st class phone license. Member of Tau Beta Pi. Desire position in research, design or development in New York metropolitan area. Box 163W.

ENGINEER

Graduate of McGill University. Age 30. Married. Desires work in radio, radar, television research or development. 4 years with National Research Council, Ottawa on radar development. 6 years of radio experience with other companies. Box 164W.

BUILD BETTER ELECTRONIC EQUIPMENT
with STANDARDIZED
READY-TO-USE CABINETS
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CHASSIS
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RACKS

PAR-METAL ELECTRONIC HOUSINGS

for ALL P. A. NEEDS
Par-Metal Equipment is preferred by Service Men, Amateurs, and Manufacturers because they're *adaptable, easy-to-assemble, economical.* Beautifully designed, ruggedly constructed by specialists. Famous for quality and economy.
Write for Catalog.

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PRODUCTS CORPORATION
32-62—49th ST., LONG ISLAND CITY 3, N. Y.
Export Dept.: Rocke International Corp.
13 East 40 Street, New York 16

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 47A)

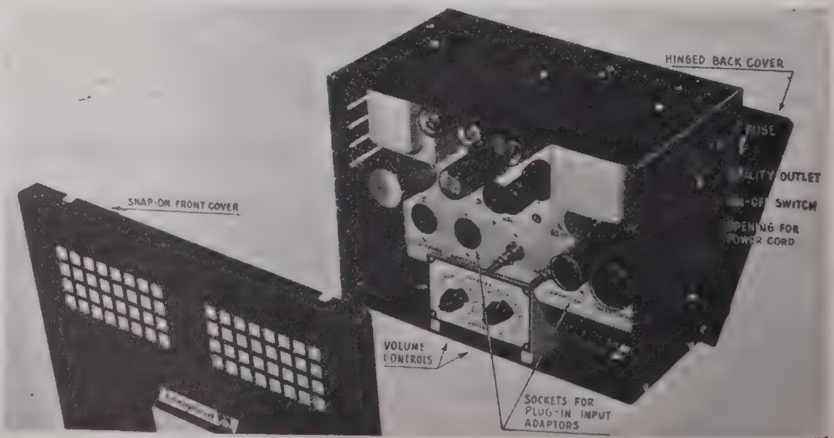
New Versatile Amplifier

Plug-in channel adapters make the Type 122 8-watt amplifier, produced by **Langevin Manufacturing Corp.,** 37 West 65 St., New York 23, N. Y., an audio unit with eight applications.

Three extra sockets are provided in each of the two input channels of the Type 122 so that various combinations of plug-in equalizers, transformers, voice filters, and vacuum tubes can adapt the amplifier for crystal pickups, radio tuners, crystal microphones, low-impedance microphones, variable-reluctance pickups (i.e., G. E. or Pickering), low-impedance pickups, line-level transmission, and magnetic-wire recorders.

The Type 122 is a low-noise-level, low-distortion unit with wide-range frequency response (8 watts with less than 3% total harmonic distortion from 50 to 15,000 c.p.s.)

The new-type chassis-cabinet with snap-on cover and hinged back facilitates maintenance.



PRECISE VOLTAGE REGULATION FOR TESTING RELAYS

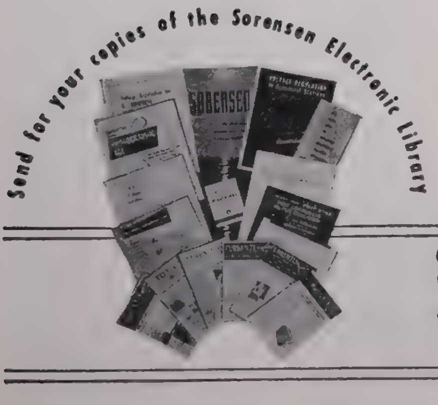
SORENSEN PROTECTS

Spencer Thermostat Company uses Sorensen voltage regulators to test their Klixon C-6360 motor starting relay. They say, "Sorensen regulators speed up our testing processes by providing a steady supply of current enabling us to turn out a uniform product."

Model 1000 shown provides full protection of your unit against *OVER LOAD* and *OVER VOLTAGE.*

Sorensen protects your equipment against over load and over voltage and at the same time provides regulation of 2/10 of 1% with a minimum of wave distortion and wide input ranges. Precision Klixons are themselves assembly line tested with Sorensen regulators. In turn, Klixon units installed in Sorensen equipment provide automatic shut-off of the output in case of over load. In practically all AC and DC units the Heinemann circuit breaker incorporated into Sorensen regulators insures against over voltage.

Write today and arrange to have a Sorensen engineer analyze voltage regulation requirements in your plant. He can select a standard Sorensen unit from 150 VA to 20 KVA to fit your most exacting application.



SORENSEN
S
& COMPANY

SORENSEN & COMPANY, INC.

375 FAIRFIELD AVENUE • STAMFORD, CONNECTICUT
The First Line of Standard Electronic Voltage Regulators

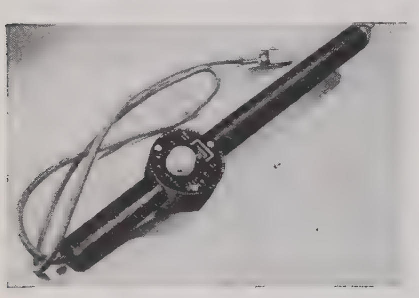
NEWS and NEW PRODUCTS

August, 1948

High-Potential Neon-Indicator Voltmeter

Covering a range from 1600 to 15,000 volts a.c., this High-Volt model 500 is intended for testing high-voltage transformers, as those used for oil-burner ignition and gas-discharge display signs, and also for television and other high-voltage electronic circuits.

In variance to the conventional meter movement, this new product of **Industrial Devices, Inc.**, Edgewater, N. J., employs a neon-lamp indicator.



To operate, the knob is turned until the neon lamp extinguished, when the voltage is read directly from the dial.

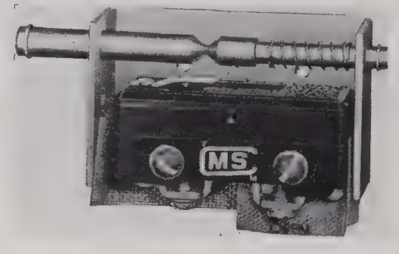
This instrument is designed for use only with transformers having one side grounded, and is not recommended for use on high-power supplies other than those of the current-limiting type, except by persons familiar with the technique of high-voltage measurements and with the necessary precautions taken.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Interlock Switch With Hold-In Feature

A new interlock door switch designed for use on high-frequency radio, radar, X-ray, and television equipment controls of all types is now being produced by **Micro Switch**, Freeport, Ill.

Positive safety is assured by this switch, as it automatically closes the circuit when the cabinet door is opened.



In servicing equipment the actuator may be manually moved to close the circuit without the danger of forgetting to return the switch to safe position, as the next door-closing automatically replaces the actuator in the normal position. This eliminates tying down a conventional switch or putting a jumper across the terminals which may be forgotten.

Underwriters' Laboratories list this switch at 10 amp., 25 volts, a.c.; 5 amp., 250 volts, a.c.; 3 amp., 460 volts, a.c.

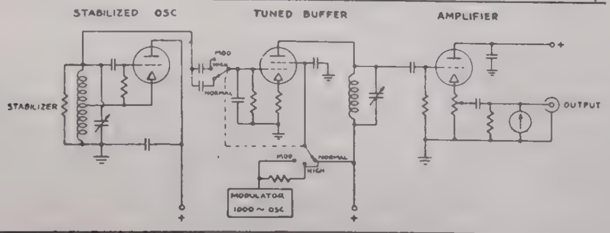
100-kc. to 10-Mc. RF Oscillator

The type 410-A r.f. oscillator, designed by **Technology Instrument Corp.**, 1058 Main St., Waltham, Mass, is a general-purpose laboratory instrument, and signal source for radio-frequency bridges.

It is provided with an output voltmeter, a continuously adjustable output-level control and an output-level switch which makes it possible to obtain minimum distortion at normal levels, higher output voltage when a small amount of distortion is tolerable and a modulated output for signal identification purposes.

The circuit features a stabilized oscillator, a tuned buffer, and a low-impedance power amplifier.

The frequency range is 100 kc to 10 Mc in six bands: 100 to 216 kc, 216 to 465 kc, 465 kc to 1 Mc, 1 to 2.16 Mc, 2.16 to 4.65 Mc, 4.65 to 10 Mc.



New Books

• • •On a booklet entitled Slide Rule Short Cuts, written by **W. P. Miller,** 536 F. St., San Diego 1, Calif. This treatise is directed mainly toward short cut methods which are useful to electrical engineers and radio technicians, who desire to improve their technique with the slide rule.

It explains clearly and concisely the "how" and "why" of short-cut methods that save both time and effort in many oft-repeated calculations.

Simple rules, which apply to both the *C* and *CI* scales when used against *D*, eliminate any uncertainty as to the location of the decimal point; this, in itself, is well worth knowing.

This second edition, priced at $1.50, may be purchased only from the author at the address listed above.

Recent Catalogs

• • •For articles of general interest to those working in the field of radioactivity and descriptive literature concerning new equipment, the April "Tracerlog" by **Tracerlab Inc.,** 55 Oliver St., Boston 10, Mass.

• • •On the new 1948 radio replacement speaker line, Catalog No. 100, with a simplified parts numbering system, by **Utah Radio Products,** Huntington, Ind.

• • •On points of interest to contract sheet-metal fabricators, Bulletin 1001, illustrating a number of different types of parts which are being fabricated by contact shops at lower cost with standard resistance welding equipment, by **Progressive Welder Co.,** 3050 E. Outer Dr., Detroit 12, Mich.

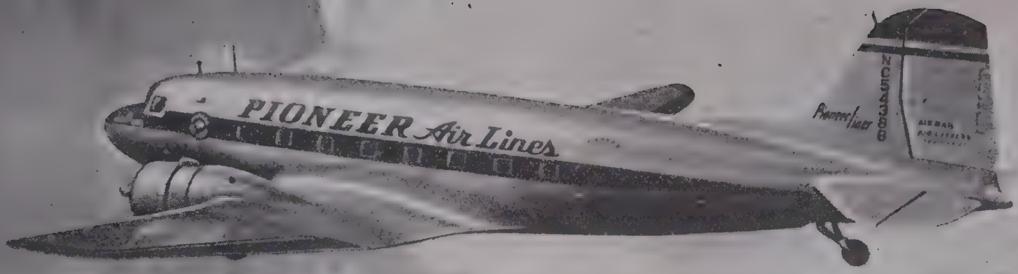
• • •On many important considerations relative to the role played by **lightning arresters** in radio, police alarm, fire alarm, railroad signal, telephone and telegraph circuits, with particular reference to the advantages of rare gas arresters over other mediums, by **L. S. Brach Mfg. Corp.,** Newark, N. J.

• • •On a 12-page booklet describing **oscillograph photography** with the Fairchild Oscillo-Record Camera, by **Fairchild Camera and Instrument Corp.,** 88-06 Van Wyck Blvd., Jamaica 1, L. I., N. Y.

• • •On a line of standard electronic voltage regulators, a color booklet with schematic drawings, by **Sorensen & Co.,** 375 Fairfield Ave., Stamford, Conn.

• • •On a number of small, compact, space-saving relays of varied types and features, with a detailed table to enumerate the specifications of each, by **Allied Control Co., Inc.,** East End Ave., New York 21, N. Y.

(Continued on page 24A)



WILCOX - *First Choice of* PIONEER *Air Lines*

PIONEER EQUIPS GROUND *STATIONS WITH Wilcox Type 378A Package Radio

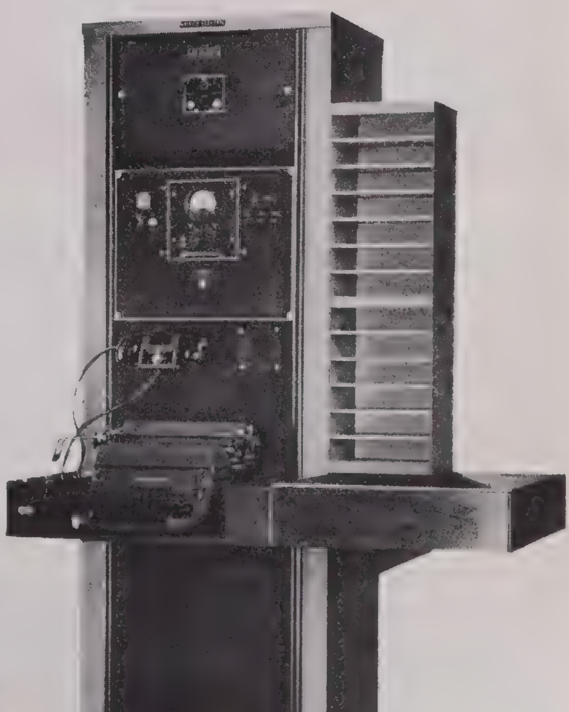
PACKAGE DESIGN SPEEDS YOUR INSTALLATIONS The Type 378A is *complete* from microphone to antenna, ready for connection to power mains. It is designed for aeronautical VHF ground-air communications at smaller traffic centers.

PROVEN COMPONENTS INSURE QUALITY AND PERFORMANCE—The Type 305A VHF Receiver and Type 364A VHF Transmitter (50 watts) are the principal components of the 378A. Long used separately and field-tested by leading airlines, these units are now available in package form.

NEW AIDS TO CONVENIENT OPERATION The telephone handset with its convenient push-to-talk button, serves as both headphone and microphone, with an auxiliary loudspeaker for incoming calls. The 378A includes desk front, message rack, and typewriter space—there are no accessories to be added.

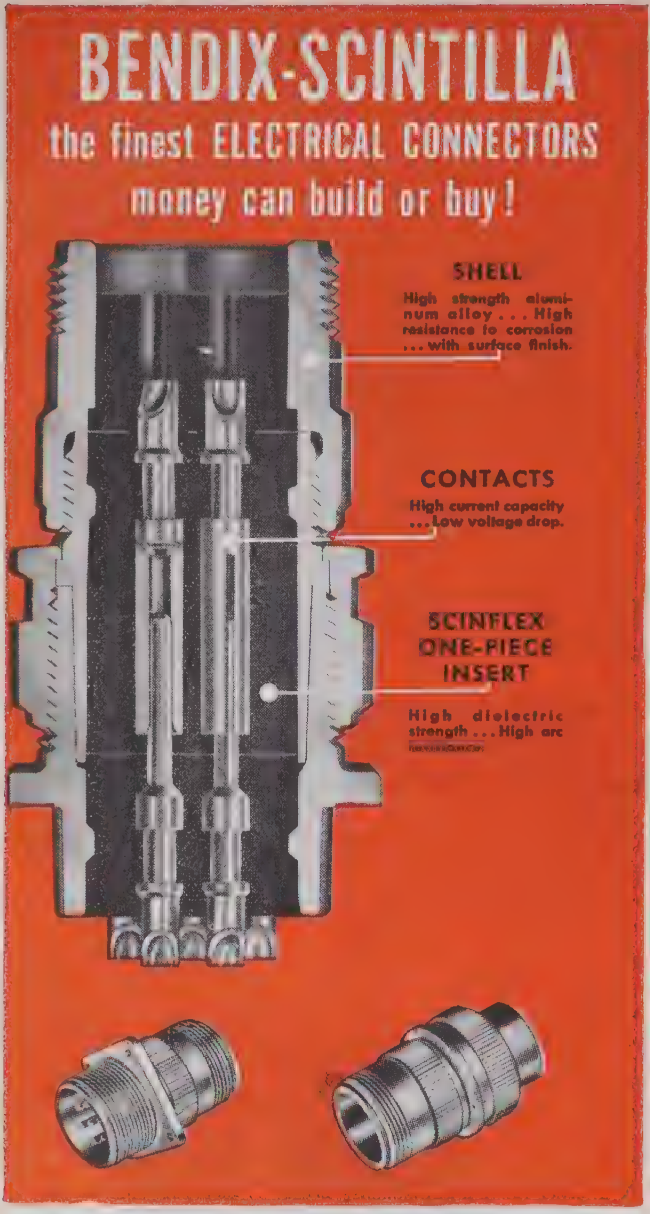
LOCAL OR REMOTE CONTROL—If desired, the control panel can be removed and the 378A remotely controlled, either by re-installing the panel at the operating position or by simple adaptation to your existing control equipment.

**Pioneer aircraft are also 100% equipped with the new WILCOX Type 361A Airborne VHF Communication System.*



WILCOX ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI
WILCOX Means Dependable Communication

Write today for complete information


BENDIX-SCINTILLA
the finest ELECTRICAL CONNECTORS
money can build or buy!
SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High arc resistance.

AND THE SECRET IS SCINFLEX!

Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—an exclusive feature that means lower maintenance cost and better performance.

*REG. U.S. PAT. OFF.

Write our Sales Department for detailed information.

- Moisture-proof, Pressure-tight
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Arc Resistance
- Easy Assembly and Disassembly
- Less parts than any other Connector

Available in all Standard A.N. Contact Configurations

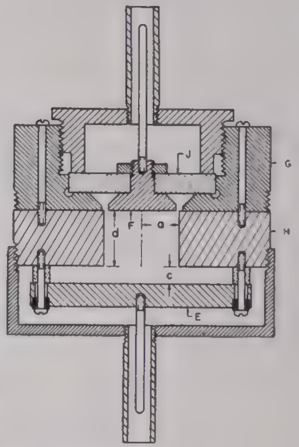
BENDIX SCINTILLA
SCINTILLA MAGNETO
SIDNEY, N. Y.
DIVISION OF
Bendix
AVIATION CORPORATION

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 20A)

Standards of Very Small Capacitance Set by N.B.S.



Under the direction of Dr. Charles Moon a new type of guarded-electrode capacitor has been designed at the **National Bureau of Standards** to provide primary standards of capacitance from 0.1 down to 0.001 micromicrofarad. The high-voltage electrode (E), is held at a fixed distance from the smaller measuring electrode (f), which is separated by a small gap from the guard ring (g). Increases in thickness of the additional guard (H), by reducing the flux to (f), decreases the measured capacitance to as low values as may be desired. The measured electrode is accurately centered in the guard ring by means of a Pyrex-glass collar (J). Capacitance is computed from measurements of the lengths *a*, *c*, and *d*.

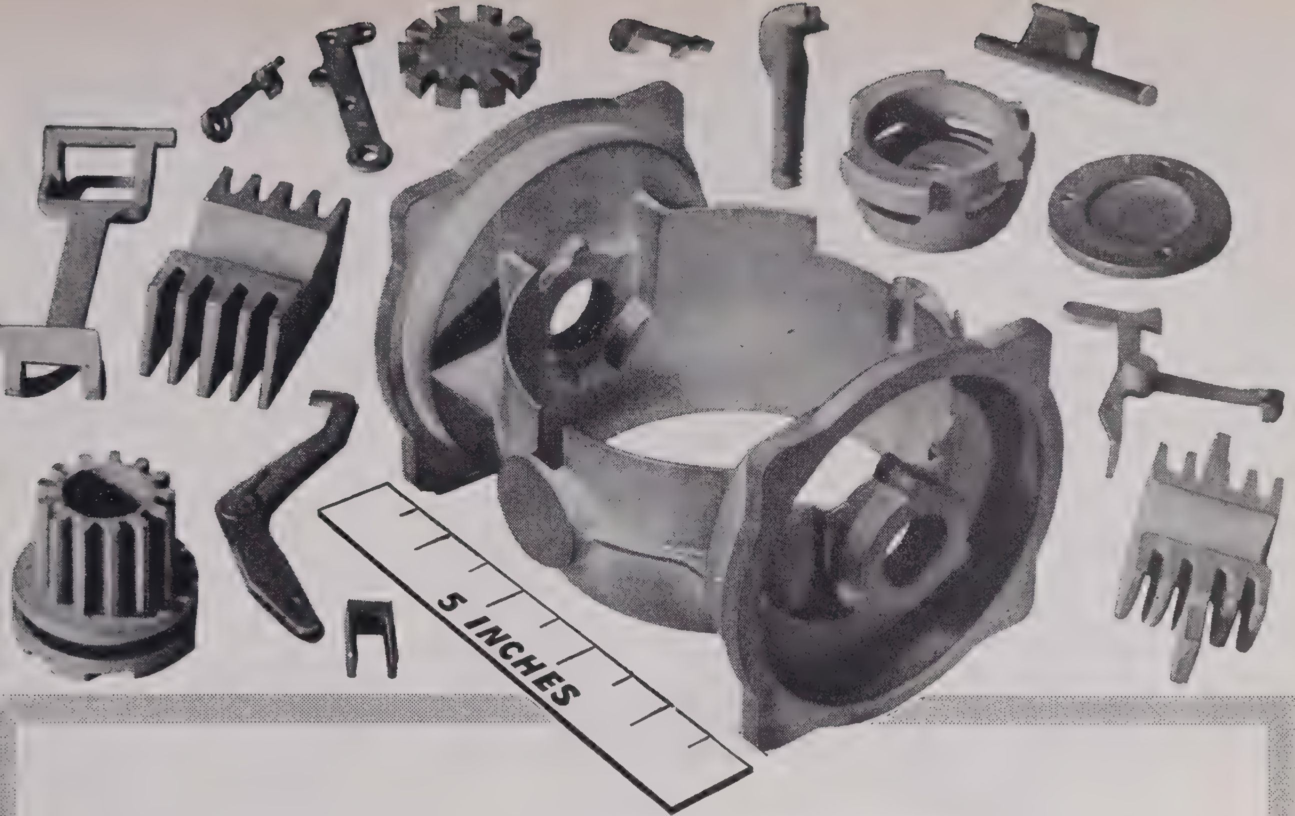
The formula for computing the capacitance was derived by Dr. Chester Snow of the Bureau on the assumption that the clearance between the island and the guard ring is infinitely small, that the edges of the hole in the guard ring are not rounded, and that the guard ring and voltage plates extend to infinity.

However, measurements on an experimental model have shown that the clearance between the island and the guard ring can be as large as several thousandths of an inch without appreciably altering capacitance, and that the high-voltage plate need extend over the edge of the guard ring for a distance only three or four times the space between the high-voltage plate and the ring. Further increase in the size of the high-voltage electrode has no measurable effect but is undesirable because it increases its capacitance to ground.

Recent Catalogs

• • • On f.m. limiters and **detectors** by Jas. H. Canning, in the April issue of "Sylvania News," Technical Section, from **Sylvania Electric Products Inc.**, P. O. Box 431, Emporium, Pa.

(Continued on page 47A)



Cast to ±.005″ accuracy!

Lower production costs, design flexibility, resistance to rust and corrosion…you get them ALL when you use INCO Nickel Alloy precision castings!

Casting, instead of forging, forming or machining saves shop time and tool costs. INCO precision castings of Monel*, Nickel, and Inconel* can usually be used *just as they come from the foundry.* The sand blast finish is so fine that additional machining is rarely required.

And as for accuracy…±.005″ per inch is the *common* production tolerance. Even closer limits can often be maintained when needed. Add to *accuracy* the fact that intricate contours are more easily produced by casting than by any other method—and you have a combination that will solve many a tough design problem.

Another important advantage…Inco Nickel Alloys can be used to greatly extend the life of a product. These rustless, strong materials are highly resistant to heat, corrosion, abrasion and fatigue.

Check with INCO if your machining costs are running high. If modern precision casting techniques can solve your problems, you will be assured of mass-production economies *plus* a dependable source of supply.

Simply send a print and a sample, if available, with the quantities needed. We will be glad to tell you whether or not precision casting is practical for your problem.

Meanwhile, perhaps you have other metal problems. Our newest publication "66 Practical Ideas for Metal Problems in Electrical Products" shows how other manufacturers have solved scores of tough design questions. Send for it today.

*Reg. U. S. Pat. Off.

The International Nickel Company, Inc.

67 Wall Street • New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS
TRADE MARK

MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

NEW!
706A
GUARD

Simple, positive protection for 9 Type Reproducers

...Inexpensive...Easy to Install

Here's how the new Western Electric 706A Guard eliminates the three major causes of damage to 9 Type Reproducers and greatly facilitates their handling.

First, it serves as an automatic latch-type support for the reproducer arm when not in use—taking the place of the armrest from which the arm may be accidentally jarred with damage to the reproducer.

Second, the 706A Guard *positively prevents any contact* between the reproducer stylus and the felt surface of the turntable and prevents the stylus from riding into the label and drive-hole area of the transcription.

Third, with the 706A Guard it is *impossible* for the stylus to hit the edge of a 16-inch transcription.

To place your order, call your local Graybar office or write Graybar Electric, 420 Lexington Ave., New York 17, N. Y.

—QUALITY COUNTS—

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Western Electric

SECTION MEETINGS

ATLANTA

"Problems of Television," by B. E. Shackelford, President, The Institute of Radio Engineers; April 7, 1948.

"Automatic Time Announcement Equipment," by J. L. Franklin, J. O. McCarty, and T. B. Franklin, Audichron Company; May 28, 1948.

BALTIMORE

"Low Temperature High-Frequency Phenomena," by J. V. Le Bacqz, Johns Hopkins University; April 27, 1948.

"Design of Current Television Receivers," by F. Norton, Bendix Radio Division; May 25, 1948.

BOSTON

"Bandwidth Reduction in Communication Systems," by W. G. Tuller, Melpar, Inc.; May 27, 1948.

BUFFALO-NIAGARA

"Underwater Surveys at Bikini by Television," by R. E. Frazier, Cornell Aeronautical Research Laboratories; April 21, 1948.

"Gas Tube Relay," by R. G. Rowe, Carborundum Company; "Electric Timer," by W. Bergerson, Electric Instrument Laboratories; "Phonograph Noise Suppression," by N. Nickolson, Colonial Radio Corporation; Election of Officers; May 19, 1948.

CEDAR RAPIDS

"Design and Application of Reflex Oscillators," by W. G. Shepherd, University of Minnesota; May 19, 1948.

CHICAGO

"New Developments in Television Transmitting Equipment," by H. Smith, Allen B. Du Mont Laboratories, Inc.; Annual Business Meeting and Election of Officers; May 21, 1948.

CINCINNATI

"Permeability Tuned Oscillators and General Applications of Permeability Tuning," by T. A. Hunter, Hunter Manfacturing Comapny; May 18, 1948.

"Dinner Meeting," A. F. Knoblaugh, Master of Ceremonies; Election of Officers; June 15, 1948.

CLEVELAND

"Institute Matters," and "Television Progress," by B. E. Shackelford, President, The Institute of Radio Engineers, Election of Officers; May 27, 1948.

CONNECTICUT VALLEY

New England Radio Engineering Meeting; May 22, 1948. Social Meeting; June 12, 1948.

DALLAS-FORT WORTH

"Factors Affecting Performance of Directional Antennas," by A. E. Cullum, Jr., Consulting Radio Engineer; June 3, 1948.

DAYTON

"Communication Systems for Aircraft," by J. E. Wilson and I. H. Bowker, Communication & Navigation Laboratory; May 13, 1948.

"Television Ghosts," by A. Alford, Andrew Alford Associates; May 27, 1948.

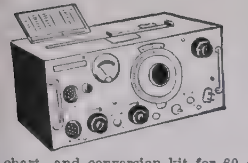
DES MOINES-AMES

"Methods of Frequency Control," by T. A. Hunter, Hunter Manufacturing Company; May 20, 1948.

(Continued on page 36A)

"Communications"

TS159 TPX



Measures frequency between 150-200 Mc. by heterodyne method. Pwr. output of XMTR can be measured directly. Measures DC voltages up to 500 V. Operates on 110 V. 400 cy. Complete with tubes, crystal, calibration chart, and conversion kit for 60 cy. $29.95

MICROWAVE TEST EQUIPMENT

W. E. I. 138 A. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00

TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity. 2700 to 2900 Mcs calibrated $85.00

3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges $15.00

3 cm. stabilizer cavity, transmission type. $20.00

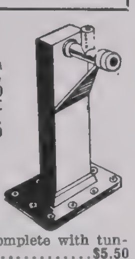
3 cm. Wavemeter, Micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,000 Mc. $75.00

"X" BAND AN/APS-15A: Compl RF head and modulator, incl. 725-A magnetron & magnet, two 723A/B klystrons (local osc & beacon), 1B24 tr. rcvr-ampl. duplexer, HV supply, blower, pulse xfmr, Pk Pwr out: 45 KW apx. Input: 115V, 400 cy. Modulator pulse duration .5 to 2 microsec. apx 13 KV. PK. pulse. Compl with all tubes, incl 715 B, 829 B, RKR 73, two 72. Compl. pkg, new $210.00

COMPLETE PKG. as above, less Modulator $150.00

MICROWAVE PLUMBING

10 CENTIMETER



"S" BAND MIXER assembly with crystal mount, pick up loop, tunable output $3.00

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated $45.00

10 CM. WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. New and complete $135.00

721-A TR CAVITY WITH TUBE. Complete with tuning plungers $5.50

WAVEGUIDE SECTION, MC 445A, rt. angle bend, 5½ ft. OA, 8" slotted section $21.00

10 CM. OSC. PICKUP LOOP, with male homedell output $3.50

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00

SHORT RIGHT ANGLE bend, with pressurizing nipple $2.00

30 FT. FLEXIBLE SECTION, ⅞ rigid to ⅞ rigid $7.50

RIGID COAX to flex coax connector $3.50

STUB-SUPPORTED rigid coax, gold plated. 5' lengths. Per length $5.00

RT. ANGLES for above $2.50

⅞" COAX. rotary joint $8.00

RT. ANGLE bend 15" L. OA. $2.00

FLEXIBLE SECTION, 15" L. Male to female ..$4.25

MAGNETRON COUPLING to ⅞" rigid coax, ⅜" I.C. line. Less "M" nut $7.50

3 CM. PLUMBING

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

TR CAVITY for 724-A TR tube, transmission or absorption types $3.50

724-A TR tube (41-TR-1) $2.50

WAVEGUIDE SECTION, CG 251/APS-15A, 26" long choke to cover, with 180 deg. bend of 2½" rad. at one end $4.00

ROTARY JOINT with slotted section and type "N" output pickup $8.50

WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2½" radius, 90 deg. bend $4.50

STABILIZER CAVITY feeding waveguide section, with filtered output and attenuating slugs $20.00

SLUG TUNER/ATTENUATOR, W.E. guide, gold plated $3.75

TR/ATR DUPLEXER section with iris flange ...$4.00

RIGHT ANGLE ELBOW, 5½" choke to cover, 2½" radius E or H plane $5.00

TWIST, 90 deg., choke to cover w/press. nipple ..$5.00

WAVEGUIDE SECTIONS 2½" long, silver plated. with choke flange $4.50

WAVEGUIDE, 90 deg., 5" band E plane, 18" long $4.00

ROTARY JOINT, choke to choke $6.00

ROTARY JOINT, choke to choke, with deck mounting $6.00

S-CURVE WAVEGUIDE, 8" long cover to choke $2.50

DUPLEXER SECTION for 1B24 ....$10.00

3 CM. WAVEGUIDE, 1" x ½", per ft. $1.50

CIRCULAR CHOKE FLANGES, solid brass .... .55

"T" SECTION (TR-ATR) choke to choke, supplied with circ. or sq. flanges $3.50

DIRECTIONAL COUPLER CG 124 APS-15A on 16" section cover to cover 15 deg., bend $5.00

FEEDBACK DIPOLE with 90 deg. twist, 7½" .$3.50

2½" FLEXIBLE SECTION, cover to cover $4.00

SHORT ARM "T" section, with additional choke output on vertical section $4.00

1.25 CENTIMETER

WAVE GUIDE Section 1" cover to cover $2.00

T SECTION choke to cover $4.50

MITRED ELBOW cover to cover $3.00

MITRED ELBOW and "S" sections choke to cover $3.50

FLEXIBLE SECTION 1" long choke to choke ..$3.00

K-BAND ROTARY Joint $45.00

2K25/723AB, X band local oscillator mount with (1) choke coupling to beacon reference cavity; (2) choke coupling to TR and receiver; (3) Iris coupling with AFC attenuator to antenna waveguide; (4) Radar AFC crystal mount; (5) Receiver crystal mount; (6) Attenuating slugs. Mfg. DeMornay Budd $22.50

TR/ATR Duplexer section for above $4.00

LABORATORY ACCESSORIES

REACTOR: .01HY, 2.5 amp. 1500 v ins "Kenyon" $3.50

BROAD BAND S THRU X themistor mount with type "N" input $8.00

SPERRY KLYSTRON TUNER Mod. 12 ....$2.00

SINE POTENTIOMETERS, GE#251x96 or W.E. #KS 15138 LO1 ....$3.50

CG 27 TYPE "N" CABLE ASS'Y, 3' long, male to female $2.50

PH-SHIFTING CAP., 180 deg. W.E. #D-150734 $2.50

KLYSTRON SOCKETS for 723 A.B. and similar types. 2 for $1.00

10 CM. McNALLY CAVITY TYPE SG. ....**From $3.00-$3.50**

LINE INSERTION ATTENUATOR, type OAX-1. 20 Db. attenuation, with 3-contact plug and socket (amphenol 16S-5) $2.25

TS 115/APS-2F 10 CM ANTENNA in lucite ball, with type "N" fitting $4.50

OAJ NAVY TYPE CYT66ADL, ANTENNA in lucite ball, with Sperry fitting $4.50

10 CM. FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola $8.00

DECADE RESISTANCE BOX. 0-1250 ohms in 250-ohms steps $2.50

DECADE CAPACITOR. .0054 mfd in 8 steps, 2500 v. ins. CD # PL 1165-120. 8" x 5¼" diam. $6.50

"PPI", ROTATING YOKE TYPE, complete with all necessary oscillator circuits, CR tube 5FP7, complete with tubes. Used with SO radar $100.00

RT39/APG-15. Transmitter-receiver. 2200-2700 mc APX. Complete with 2C43 lighthouse plumbing. TR, 30 mc. I.F., all enclosed in compact pressurized housing. New, less tubes $100.00

CP 14 APS-15A COMPUTER. Compiles slant range-ground range against altitude $15.50

CURSOR DIAL ASSEMBLY for 7" CR tube. Azimuth calibrated to 360 deg. Roller bearing mech. ..$12.50

BC 701-A RADAR RECEIVER, Part of SCR 521 and ASE eqpt. 176 mc operation, receives bilobed search and homing patterns. Complete with tubes and antenna switching motor $37.00

BC 704-A SCOPE, part of SCR 521 and ASE equipment. "L" scope with linear range sweep. With all tubes, including 5BP1 ....$17.50

YAGI ANTENNA SWITCHING MOTOR for ASE and SCR 521 sets. Operates on 24 v.d.c., at 1800 RPM. DPDT $2.00

COAXL CONNECTORS

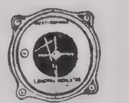
831R	$.35	**UG 21/U**	$.85
831SP	$.35	**UG 86 U**	$.95
831AP	$.35	**UG 254/U**	$.75
831HP	$.15	**UG 255/U**	$.85

Homedell male to type "N" male adapter $1.25

RT ANGLE Sperry fittings $1.00

THERMISTORS ($.95 ea.)	VARISTORS $.95 ea.
D-167332 (Bead)	D-167176
D-170396 (Beal)	D-170225
D-168391 (Button)	D-168687
D-166228 (Button)	D-171121
D-167018 (Tube)	D-171631

CROSS POINTER INDICATOR



Two 0-200 microamp. movements in 3" case. Each movement brought out to 6-term. receptacle at rear. Originally used in ILS equipment. New **$2.50**

5J30 THE NEWEST THING IN UHF. 10-350 MC. MAGNETRON IN GLASS ENVELOPE. NEW, COMPLETE WITH DATA SHEET $39.50

TUBE	FRQ. RANGE	PK. PWR. OUT.	PRICE
2J31	2820-2860 mc.	265 KW.	$15.00
2J22A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$15.00
2J26	2992-3019 mc.	275 KW.	$15.00
2J27	2965-2992 mc.	275 KW.	$15.00
2J32	2780-2820 mc.	285 KW.	$15.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267-3333 mc.	8.7 KW.	$25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	$25.00
3J31	24,000 mc.	50 KW.	$17.00
714AY			$15.00
720BY	2800 mc.	1000 KW.	$25.00

KLYSTRONS: 723A/B $7.75 707B W/CAVITY $20.00

MAGNETS

For 2J21, 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31 ....Each $8.00

4850 Gauss, ⅝" bet. pole faces, ¾" pole diam. ..$8.00

1500 Gauss, 1½" bet. pole faces, 1⅝" pole diam. $8.00

1000 Gauss, electromagnet, adjustable 2⅜" to 3" bst. pole faces, 2½" pole diam. $12.00

TUNABLE PKG'D "CW" MAGNETRONS

QK59 2675-2900 Mcs.	QK61 2975-3200 Mcs.
QK60 2800-3025 Mcs.	QK62 3150-3375 Mcs.
.. **New—$45 each**	**New—$55 each**

WATER COOLED TUBES

GL697	GL623	GL562

GUARANTEED ....$75.00 EA.

PULSE EQUIPMENT

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk); pulse rate 200 PPS, 1.5 microsec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New, with all tubes $49.50

PULSE TRANSFORMERS

G.E. #K2731	$19.50	W.E. #D166173	$12.50
K2150A	$15.00	KS9948	$6.50
K2748A	$12.00	KS9800	$2.00
W.E. #D169271	$9.95	Utah 9318 or 9280	$1.25
705A	$1.95	715B	$8.50

Sockets for 705A, 715B ....$.69 ea.

CONDENSER DRIVE

Rotates any coupled condenser by means of motor thru 90 deg. at rate of 5 deg. per min. Operates on 55-110 vac. 60 cy. Manual knob permits rough adjustment. WE #B401020-Gl. New, complete with cover and 0-90 deg. indicator scale $12.50

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Price*
BD 77KM	14	40	1000	.350	BC 191	$12.00 N $7.95 LN
PE 73	28	19	1000	.350	BC 375	$8.95 N
DM 21	14	3.3	235	.090	BC 312	$3.45 LN
DM 21CX	28	1.6	235	.090	BC 312	$3.45 N
DM 25	12	2.3	250	.050	BC 367	$2.49 LN
DM 28R	28	1.25	275	.070	BC 348	$5.75 N
DM 33	28	7	540	.250	BC 456	$5.50 N
DM 42	14	46	515 1030 2/8	.110 .050	SCR 506	$6.50 LN
PE 55	12	25	500	.400	SCR 245	$5.25 LN
PE 86 N	28	1.25	250	.060	RC 36	$3.95 N
PE 101 C	13/26	12.6/ 6.3	400 800 9 AC	.135 .020 1.12	SCR 515	$5.25 N
BD AR 93	28	3.25	375	.150		$4.95 N
23350	27	1.75	285	.075	APN-1	$3.50 N
35X045B	28	1.2	250	.060		$3.50 N
ZA .0515	12/24	4/2	500	.050		$3.95 N
ZA .0516	12/24	8/4	275	.110		$4.25 N
B-19 pack	12	9.4	275 500	.110 .050	Mark II	$9.95 N

*N—New. LN—Like New.

POWER EQUIPMENT

STEP DOWN TRANSFORMER: Pri: 440/220/110 volts a.c. 60 cycles, 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7" $40.00

PLATE TRANSFORMER. Pri: 117 v. 60 cy. Sec. 17,000 v. @ 114 ma, with choke. Oil immersed. Size: 26" x 29" x 13". Amertran $65.00

FIL. TRANSFORMER: Pri: 220 v.a.c., 60 cy; .05KVA. Sec. 5 v.c.t., 34,000 v. test $24.50

FIL. TRANS. UX6899. Pri: 115 V, 60 cyc. Sec: Two 5 v, 5.5 amp wdgs. 29KV Test $24.50

PLATE TRANSFORMER: Pri: 115/230 v.a.c., 50-60 cy. Sec: 21,000 v, 100 ma $145.00

LINE VOLTAGE REG Pri: 92-138 v 57/63 cy. 1ph15A Sec 115 v 7.15 A .82 Kw 96% PF $99.50

"TRANSTAT" VOLTAGE REG. 11.5 KVA, 0-115 vac, 60 cy. 100 amps $75.00

VOLTAGE REG Transtat. Amertran type RH 2 KVA load. input: 90/130 V. 50-60 cy output 115 v ..$40.00

ITE CIRCUIT BREAKER, 115 A, 600 V $15.00

400 CYCLE TRANSFORMERS

PLATE XFMR: Pri: 115 v, 400 cy. Sec: 9800 v or 8600 v @ 32 ma dc. $12.50

#12033, Plate Xfmr: Pri: 115 v, 800 cy. Sec: 4550 vct. 250 ma. $4.50

KS 9445, Pwr Xfmr. Pri: 115 v, 400-2400 cy. Sec: 592 vct, 120 ma, 6.3v, 8 amp; 5v, 2 amp. $3.50

PLATE XFMR. Pri: 115 v, 400-2400 cy. Sec: 4500 v. 6 ma $6.50

#7143. Pri: 115 v, 400 cy. Sec: 6.3 v, 7 amp, 8.3 v, 8.8 amp; 6.3 v. 1.3 amp $2.50

FIL XFMR: Pri: 115 v, 400 cy. Sec: 6.3 v, 9 amp; 6.3 vct, .65 amp; 2.5 v, 3.5 amp; 2.5 v, 3.5 amp ...$3.25

KS 9584. Pri: 115 v, 400 cy. Sec: 5,000 v, 290 ma; 5 v, 10 amp, size: 7" x 10" x 6" $15.00

Pri: 115 v, 380-2800 cps. Sec: 2200 v, 350-VA. open frame $3.95

PLATE XFMR: Pri: 115 v, 400 cy. Sec: 1150-0-1150 v, 40 ma. GE. 68G631 ....$1.75

INVERTERS

PE 206-A. Input: 28 VDC @ 38 amp. Output: 80 volts @ 500 volt-amps. 800 cycles. Leland. New, complete with enclosed relay, filter, instruction book ...$12.50

PE 218: Input: 25-28 VDC @ 92 amps. Output: 115 volts @ 1500 volt-amps. 380-500 cycles. Poor physical but good running condition $12.50

DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism $65.00

AS-125/APR Cone type receiving antenna. 1000 to 3200 megacycles. New $4.50

30 FT. MAST SETS

Heavy duty rugged plywood. Crated in 3 sections with coupling material. Two masts for ideal flat-top antenna. Unused ....$40.00 per set

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TRUSCON SELF-SUPPORTING AND UNIFORM CROSS SECTION GUYED TOWERS

SECTION MEETINGS

(*Continued from page 34A*)

EMPORIUM

"Secondary Emission as a Function of Temperature," by G. Hees, Sylvania Electric Products Inc.; June 3, 1948.

HOUSTON

"Atomic Physics, Detection of Subatomic Particles," by J. H. Stewart, Industrial Radiography Laboratory; Election of Officers; May 17, 1948

LONDON (CANADA)

"Applications of Electronics to Bio-Physics," by A. Burton, University of Western Ontario; Election of Officers; April 23, 1948.

"Magnetic Tape Recording," by T. E. Lynch, Brush Development Company; May 14, 1948.

LOS ANGELES

"Remote Control Television Lighting," by W. C. Eddy, WBKB, Balaban & Katz; "Stereophonic Magnetic Recorder," by M. Camras, Armour Research Foundation; "Television Studio Systems," by M. A. Trainer, Radio Corporation of America; May 20, 1948.

LOUISVILLE

"The Baldwin Electronic Organ," by J. F. Jordon, Baldwin Company; Election of Officers; May 14, 1948.

MONTREAL

"Transmission Considerations in Radio Systems for Telephone Service," by S. T. Fisher and C. B. Fisher, F. T. Fisher's Sons, Ltd.; April 28, 1948. Field Trip to RCAF Station; Election of Officers; May 15, 1948.

NEW MEXICO

"Television Progress," by P. J. Larsen, Los Alamos Scientific Laboratories; May 14, 1948.

"Application of Electronics in Nuclear Research, by H. G. Weiss, Los Alamos Scientific Laboratories; June 18, 1948.

NEW YORK

"A New 15-Kw Transmitter for Standard Band Broadcasting," by T. J. Boerner, Radio Corporation of America; April 22, 1948.

PRINCETON

"Reproduction of Sound," by H. F. Olson, Radio Corporation of America; Election of Officers; Annual Business Meeting; May 13, 1948.

ROCHESTER

"Simultaneous AM-FM Communication," by J. C. O'Brien, General Railway Signal Company; Election of Officers; May 27, 1948.

SACRAMENTO

"Our Interesting Universe," by L. E. Reukema, University of California; Annual Meeting; May 18, 1948.

"Stub Matching of RF Transmission Lines," by W. E. Evans, Jr., McClatchy Broadcasting Company; Election of Officers; June 15, 1948.

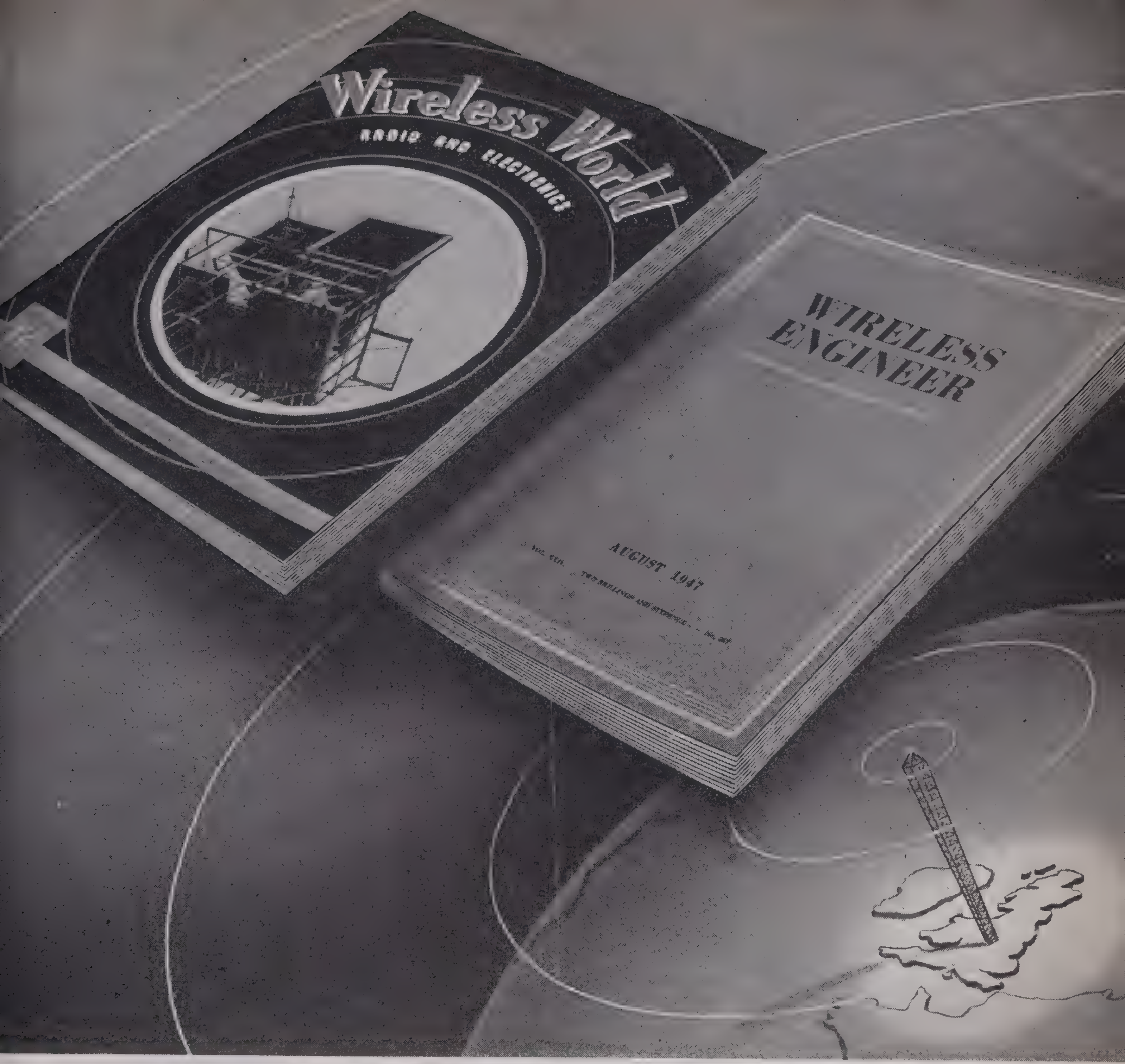
ST. LOUIS

"Telephones on Wheels," by M. W. Waggoner, Southwestern Bell Telephone Company; May 27, 1948.

SAN DIEGO

"An Analysis of Linear Modulation in a Diode," by M. W. Alnutt, U. S. Navy Electronics Laboratory; May 4, 1948.

(*Continued on page 38A*)



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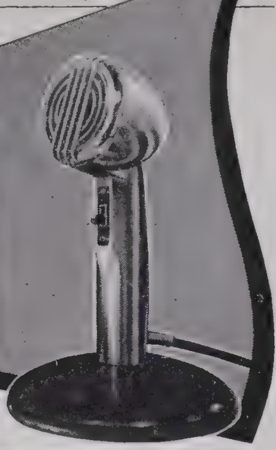

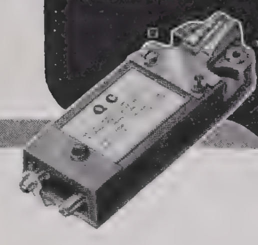

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Write for prices, specifications

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IN CANADA: CANADIAN ASTATIC LTD. TORONTO, ONTARIO

SECTION MEETINGS

(Continued from page 36A)

San Francisco

"Television—Its Mechanism and Promise," by W. L. Lawrence, Radio Corporation of America; May 12, 1948.

"Television Receiver Installation and Servicing Problems," by E. Edison, RCA Television Receiver Installation Shop; June 9, 1948.

Toledo

"Miniature Tubes," by G. H. Floyd, General Electric Company; May 25, 1948.

Twin Cities

"Components and Tubes for Television Receivers," by H. E. Hafker, Radio Cororpation of America; May 5, 1948.

"Atomic Energy," by A. O. C. Nier, University of Minnesota; May 26, 1948.

Washington

"Reproduction of Sound," by H. F. Olson, Radio Corporation of America; May 10, 1948.

"Projection Television Receiver Design Features," by E. L. Clark, Radio Corporation of America; June 14, 1948.

SUB-SECTIONS

Lancaster

"The Engineer and the Community," by D. A. Distler, Franklin & Marshall College; May 14, 1948.

Long Island

"Fundamental Limitations of Wide-Band Amplifiers," by H. A. Wheeler, Wheeler Laboratories; April 14, 1948.

"Pulse Multiplex System for Distance Measuring Equipment," by C. Hirsch and Lois Stewart, Hazeltine Electronics Corporation; Election of Officers; May 12, 1948.

Monmouth

"Maxially Flat Filters in Waveguides," by W. W. Mumford, Bell Telephone Laboratories, Inc.; "A New Microwave Filter," by J. R. Pierce, Bell Telephone Laboratories, Inc.; Election of Officers; June 16, 1948.

STUDENT BRANCH MEETINGS

Alabama Polytechnic Institute, I.R.E. Branch

Election of Officers; May 17, 1948.

"Electronic Computers," by Mr. Sayre, Alabama Polytechnic Institute; June 21, 1948.

University of Arkansas, I.R.E. Branch

Election of Officers; May 19, 1948.

Polytechnic Institute of Brooklyn, I.R.E. Branch

"My Experiences in the E.T.O.," by C. A. Hachemeister, Polytechnic Institute of Brooklyn; May 11, 1948.

(Continued on page 40A)

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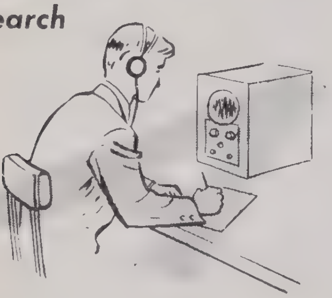
COMMUNICATIONS Today a large utility company has a satisfactory communication system between its central location and its mobile units because **ADC** engineers worked out technical transformer applications for the maker of a power line carrier telephone. From model stage to production this company depended upon the skill of **ADC** transformer design and production. You, too, will find **ADC** helpful in all unusual model work as well as production.

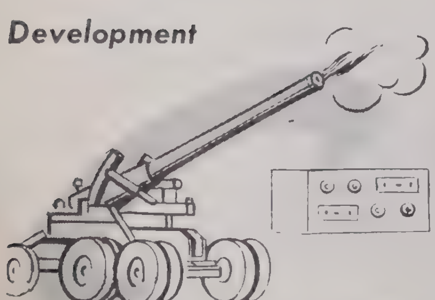
ENGINEERING The development of a computer to check the muzzle velocity of a cannon with greater accuracy required many special transformer applications. This job is typical of scores of development tasks presented to **ADC** engineers from university laboratories, communication developments, guided missile programs and developmental engineers everywhere. **ADC** supplies transformer "know how" with excellent transformer production to assure you a reliable source of dependable transformers.

Research



Models

Development



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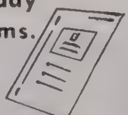

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STUDENT BRANCH MEETINGS

(Continued from page 38A)

California Institute of Technology,
I.R.E. Branch

Business Meeting; May 17, 1948.

University of California, I.R.E.—
A.I.E.E. Branch

"The California Engineer's Registration Act," by A. Tittes, PG&E; May 13, 1948.

California State Polytechnic College,
I.R.E. Branch

"Operational Analysis of a 2000-Cycle Class-C, Amplifier," by H. Engwicht, San Jose State College; May 20, 1948.

University of Illinois, I.R.E.—
A.I.E.E. Branch

Business Meeting; April 29, 1948.

Manhattan College, I.R.E. Branch

Election of Officers; May 19, 1948.

University of Michigan, I.R.E.—
A.I.E.E. Branch

Spring Vacation Field Trip; April 2 to Mpril 11, 1948.

"Plants versus Engineers," by W. C. Steere, University of Michigan; Election of Officers; May 19, 1948.

College of the City of New York,
I.R.E. Branch

Election of Officers; May 11, 1948.

North Carolina State College,
I.R.E. Branch

Election of Faculty Representative; May 12, 1948.

"Radar Waveguide Transmission Techniques," by R. Peters, Western Electric Company; May 26, 1948.

Northwestern University, I.R.E.—
A.I.E.E. Branch

Discussion of Field Trip; April 8, 1948.

Field Trip and Dinner; April 15, 1948.

"The Business Physician—A Consultant Engineer," by H. F. Fruth; April 29, 1948.

"After Commencement, What Next?" by T. G. LeClair, Commonwealth Edison Company; May 13, 1948.

"The Art of Selling Technical Knowledge," by O. Eisenschiml, Scientific Oil Compounding Company; May 21, 1948.

Business Meeting; May 27, 1948.

Princeton University, I.R.E.—
A.I.E.E. Branch

Election of Officers; May 11, 1948.

St. Louis University, I.R.E. Branch

"The Proximity Fuse," by F. W. Bubb, Washington University.

Election of Officers; May 11, 1948.

Stanford University, I.R.E.—
A.I.E.E. Branch

"Basic Problems of Vacuum-Tube Construction," by R. H. Gordon, Stanford University; Election of Officers; May 19, 1948.

(Continued on page 42A)

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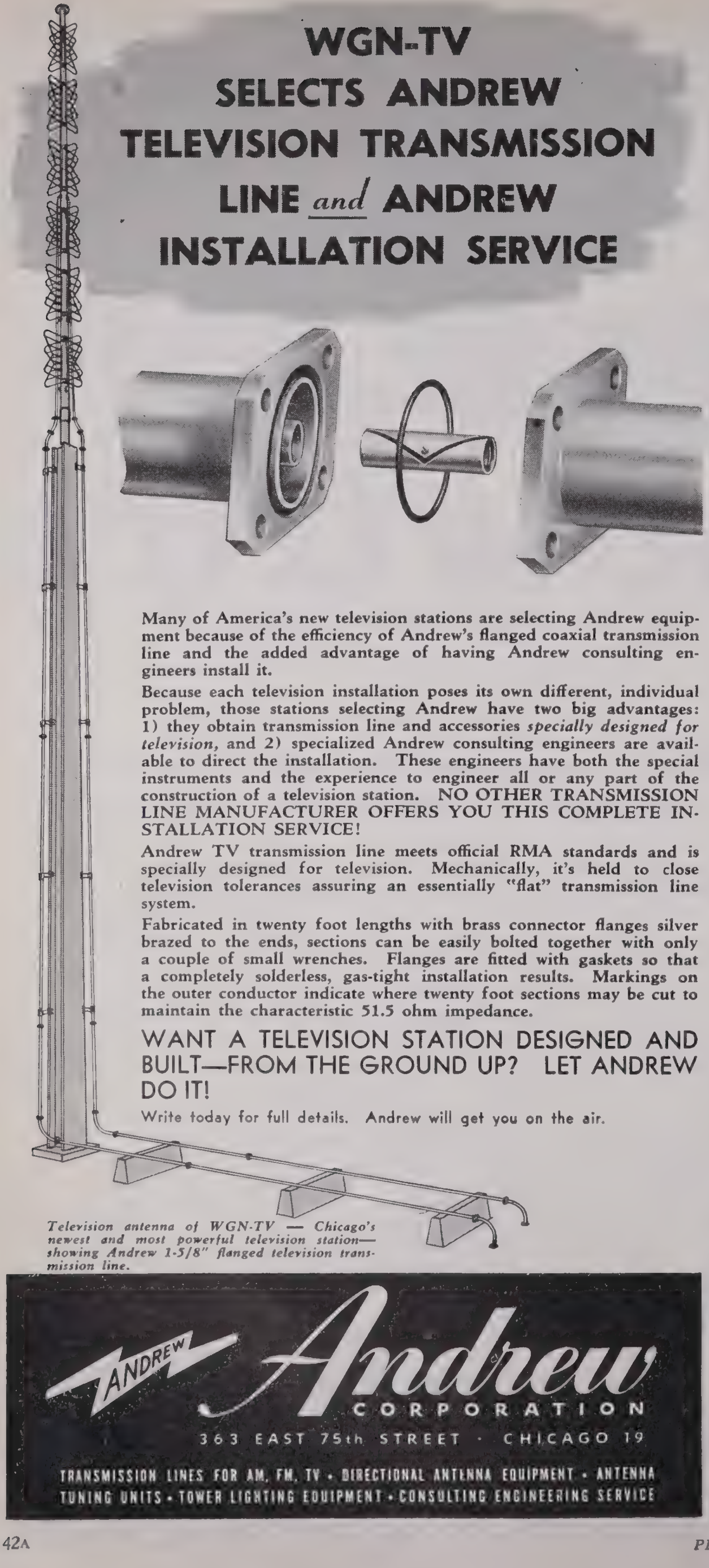

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STUDENT BRANCH MEETINGS

(Continued from page 40A)

UNIVERSITY OF TEXAS, I.R.E.—
A.I.E.E. BRANCH

"Report on Regional Meeting," by D. Spence, Student; April 26, 1948.
Social Meeting; May 8, 1948.
Election of Officers; May 10, 1948.

UNIVERSITY OF UTAH, I.R.E.—
A.I.E.E. BRANCH

"Mk 16 Radar," by G. Wade, J. E. Edwards, R. W. Grow, C. L. Alley, D. R. McAllister, and W. R. Tate, Students; May 3, 1948.

UNIVERSITY OF WASHINGTON, I.R.E.—
A.I.E.E. BRANCH

Nomination of Officers; May 21, 1948.
Election of Officers; June 3, 1948.

WORCESTER POLYTECHNIC INSTITUTE,
I.R.E.—A.I.E.E. BRANCH

"Broadcasting," by E. Browning, WTAG & WTAG-FM; Election of Officers; May 11, 1948.
Business Meeting; May 18, 1948.

MEMBERSHIP

The following transfers and admissions were approved on July 7, 1948, to be effective as of August 1, 1948:

Transfer to Senior Member

Carlisle, R. W., Box 107, Elmsford, N. Y.
Clarke, J. R., School of Electrical Engineering, Purdue University, Lafayette, Ind.
Fancher, H. B., 178 Hickok Ave., Syracuse 6, N. Y.
Hinsdale, E. M., Jr., 2025 S. Randolph St., Arlington, Va.
Holmes, L. C., Stromberg-Carlson Co., 100 Carlson Rd., Rochester 3, N. Y.
Olson, H. F., Acoustical Research Laboratory, RCA Laboratories Division, Princeton, N. J.
Powles, F. T., 5030 Benning Rd., S.E., Washington 19, D. C.
Rhys-Jones, J. E., Three Ways, Sykecluan, Iver. Bucks., England
Waldock, D. A. G., c/o Directorate of Armament Development, Army Headquarters, Ottawa, Ont., Canada
Wallace, J. W., Radio KPQ, Wenatchee, Wash.
Wells, F. H., Atomic Energy Research Establishment, T.R.E., Malvern, Worcs., England

Admission to Senior Member

Arenstein, G. H., 29 Colin Kelly Dr., Dayton 3, Ohio
Edwards, M. A., 805 Sanders Ave., Scotia, N. Y.
Harden, J. G., 240 N. Meridian St., Indianapolis 9, Ind.
Koch, R., 72 Via del Mascherino, Rome, Italy
Krause, R. A., 536 Huron Ave., Cambridge 38, Mass.
Rutelli, G., Via Sturla 39-B/6, Instituto Di Elettrotecnica, Universita Di Genova, Genua, Italy
Wankel, F. A., 30 Rockefeller Plaza, New York 20, N. Y.

(Continued on page 44A)

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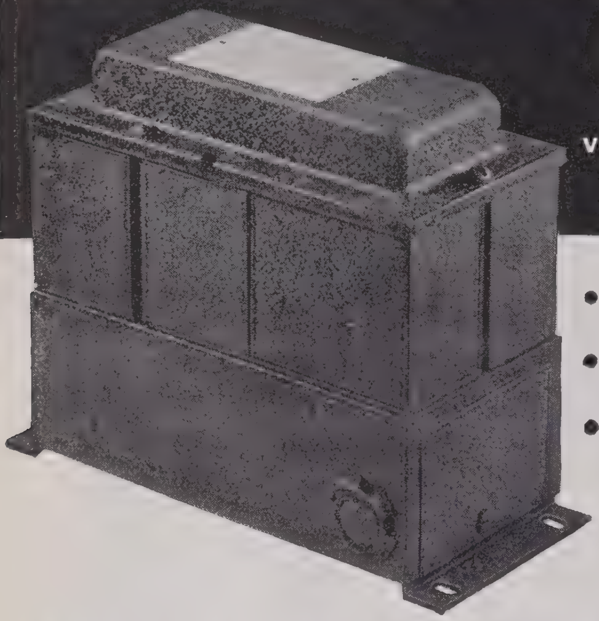

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(Continued from page 42A)

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Alterman, F. J., 25-40-31 Ave., Long Island City, L. I., N. Y.
Anspach, K. E., Sylvania Electric Products Inc., 40-22 Lawrence St., Flushing, L. I., N. Y.
Braude, A. N., c/o Hong Kong Telephone Company Ltd., Hong Kong, China
Brooks, F. E., Jr., 702 W. 25 St., Austin 21, Texas
Brown, D. R., 115 Hemenway St., Apt. 16, Boston 15, Mass.
Danziger, A., 910 Park Pl., Brooklyn 16, N. Y.
Dasburg, A. V., 55 Stonybrook Dr., Rochester 10, N. Y.
Dorrell, R. E., Electron Tube Laboratory, National Bureau of Standards, Washington 20, D. C.
Farrell, F. X., 105 Tobey St., Providence 9, R. I.
Gossland, R. D., G. M. Giannini & Company, 285 W. Colorado St., Pasadena 1, Calif.
Grobecker, A. J., 2395 Woodlyn Rd., Pasadena 7, Calif.
Hauser, W. H., 112 Warren St., Newton Center 59, Mass.
Holmboe, L. W., 1400 Packard St., Ann Arbor, Mich.
Huntley, K. L., Radio Division III, Naval Research Laboratory, Washington 20, D. C.
Jackson, A., Box 101, Hollyburn, B. C., Canada
Julian, R. S., University of Illinois, Champaign, Ill.
Kirkland, G. I., 8006 Piney Branch Rd., Silver Spring, Md.
Korin, S. B., 129 Wadsworth Ave., New York 33, N. Y.
Lawton, B. E., 1942 Birchwood Ave., Chicago 26 Ill.
Lee, L. K., 284 Ninth St., Oakland 7, Calif.
Leifer, M., 632 Leonard St., Brooklyn 22, N. Y.
MacKechnie, H. K., 146 Langley Rd., Newton Center, Mass.
Managan, W. W., 3800 Perkins Ave., Cleveland 14, Ohio
McCallum, D. M., The Rectory, Bathgate, West Lothian, Scotland
Miller, J. L., 2416 S. Dinwiddie St., Arlington, Va.
Nasmyth, P. W., 73 Renfrew Ave., Ottawa, Ont., Canada
O'Connor, D. G., 6823 Ridge Blvd., Brooklyn 20, N. Y.
Onyskin, M., Sperry Gyroscope Co., Great Neck, L. I., N. Y.
Pritchard, W. L., 287 Newbury St., Boston 15, Mass.
Rehkopf, C. L., 6308-23, N.E., Seattle 5, Wash.
Rosenbaum, J., 44 S. Madison Ave., Spring Valley, N. Y.
Russell, J. D., Radio Station WHIR, Danville, Ky.
Russell, J. H., 2914 S. Buchanan St., Arlington, Va.
Skerrey, C. E., 8 Wyver Crescent, Coventry, Worces., England
Southwell, J. D., 371 Forrest St., Beaumont, Texas
Stanton, I. W., 4078 Ninth Ave., Los Angeles 43, Calif.
Trotter, G. C., 134-A Brattle, Cambridge 38, Mass.
Wilson, D. G., EEL 203, University of Kansas, Lawrence, Kan.
Zimmerman, S., 135 Prospect Park, S.W., Brooklyn 18, N. Y.

Admission to Member

Ames, B. C., 7504 Nestle Ave., Reseda, Calif.
Beier, L. W., 600 S. Michigan Ave., Chicago 5, Ill.
Behrend, W. L., 564 S. Main St., Hightstown, N. J.
Bergquist, P., 982 National Press Bldg., Washington 4, D. C.
Bloom, M. S., 1058 W. Loyola Ave., Chicago 26, Ill.
Brown, V. A., 3929 Newdale Rd., Chevy Chase 15, Md.
Bruning, J. M., New York Group, Atlantic Reserve Fleet, U. S. Navy, Bayonne, N. J.
Coles, D. K., Westinghouse Research Laboratories, Pittsburgh, Pa.

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Feldman, B., Farnsworth Tel. and Radio Corp., Fort Wayne 1, Ind.
Greeff, C. E., 1010 Cameron Ave., Lancaster, Pa.
Harrison, S. W., 37-41-79 St., Jackson Heights, L. I., N. Y.
Hidalgo, M. T., Box 332, Carnegie Institute of Technology, Pittsburgh, Pa.
Iversen, J., c/o Hewlett-Packard Co., 395 Page Mill Rd., Palto Alto, Calif.
Knoop, I. L., 340 Baldwin Rd., Akron 6, Ohio
Larsen, J., 321 W. Cortland St., Jackson, Mich.
Metcalf, D., 4404 Ramsey Ave., Austin, Texas
Morrin, T. H., 194 Islington Rd., Auburndale 66, Mass.
Morrison, R. T., 1423 Tower Rd., Winnetka, Ill.
Morton, H. B., 2, Lawn Ave., West Drayton, Middlesex, England
Myers, M. C., Jr., 14 Columbus Ave., Montclair, N. J.
Ransom, D. H., R.D. #1, Paterson, N. J.
Roe, J. N., 5 Gloucester Rd., Hampton-on-Thames, Middlesex, England
Ryan, W. R., Wesskum Wood Rd., Riverside, Conn.
Saari, L. V., 722 N. Broadway, Milwaukee 2, Wis.
Savage, L. E., 1033 W. Van Buren St., Chicago 7, Ill.
Schrank, H. E., 1611 Maple St., Fort Lee, N. J.
Sharma, S. B., Asst. Wireless Officer, U.P. Police Wireless, Dilkoosha Rd., Lucknow, U.P., India
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Torrey, B. M., 50 Churchill St., Milton 87, Mass.
Vollenweider, A. D., 205 Halstead Ave., Mamaroneck, N. Y.
West, C. F., 4 Pilgrim Rd., Watertown, Mass.
Wiley, C. A., 213 S. College St., W., Yellow Springs, Ohio
Wood, G. V., 1097 Green St., San Francisco 11, Calif.

The following admissions to Associate grade have been approved and will be effective as of July 1, 1948:

Adams, C. E., Jr., 2114 Reading Rd., Cincinnati 2, Ohio
Adler, D. P., 2604 Rosewood Ave., Baltimore 15, Md.
Bennett, N., 37 Pulaski St., Brooklyn 6, N. Y.
Benson, H. H., Box 2175, Houston 1, Texas
Blasbalg, H., 24 W. Rosemont Ave., Alexandria, Va.
Blevins, E. L., 9134 S. 53 Ave., Oak Lawn, Ill.
Brittle, D. F., Jr., 319 Bond Bldg., Washington 5, D. C.
Brown, E. B., 4922 W. 58 St., Mission, Kan.
Channon, K. F., Jr., 54 Rhode Island Ave., N.W., Washington, D. C.
Collins, B. G., "Winchmore," Ashurst Rd., Cockfosters, Herts., England
Collins, P. B., c/o Pan American Airways, Box 257, San Juan, Puerto Rico
Curts, O., 6934 Narcissus, Houston 17, Texas
Dellinger, J. T., 3846 Central Ave., San Diego 5, Calif.
deSouza, F. X., 1434 Monroe St., N.W., Washington 10, D. C.
Earp, T. N., 115 N Ave. 52, Los Angeles 42, Calif.
Fehlmann, H. Soneggstr. 27, Zürich 6, Switzerland
Feldman, H., 3306 W. Eastwood Ave., Chicago 25, Ill.
Ferreira, H. M., Av. Pasteur 458, Rio de Janeiro, Brazil
Fisher, P. A., 400 Golfview Ave., Dayton 6, Ohio
Funk, H. N., 2122 E. Pontiac Blvd., Fort Wayne 5, Ind.
Ghose, R. N., India 15 R. B. Saha 1st. Bye Lane, Howrah, Bengal, India
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(Continued on page 46A)

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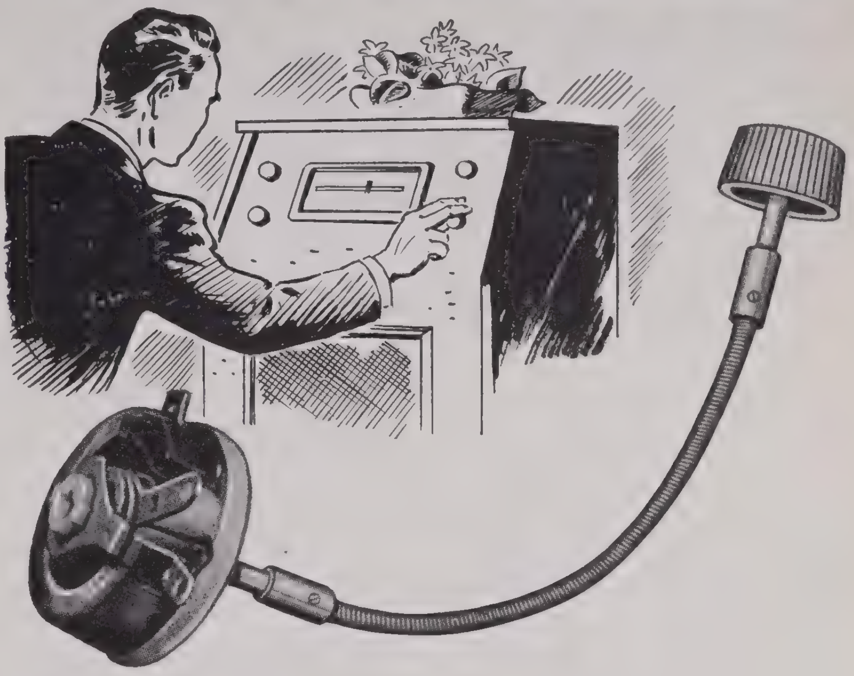

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(Continued from page 45A)

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Herbin, L., 1140 Anderson Ave., Bronx 52, N. Y.
Herbst, J. J., 178 Ash St., Valley Stream, N. Y.
Jackson, J. E., Woute 1, Philpot, Ky.
Jones, C. T., 327 Trust Co. of Georgia Bldg., Atlanta 2, Ga.
Kassner, M. H., 2, Soudan Rd., London S.W. 11, England
Krishnamurthy C. R., Sound Section, National Bureau of Standards, Washington 25, D. C.
Lantz P. A, 521 Oakwood St., S.E., Washington, 20, D. C.
Leslie, E. E., Jr, 50 Shore Dr., Plandome, L. I., N. Y.
Matheson, R. M., Box 2-98, R.F.D. 2, Princeton, N. J.
Matovich, J., 202 First Ave., New York 3, N. Y.
McHale, K. S., 3313 17 St. N.W., Washington 10, D. C.
Meaney, M. H., Jr., National Broadcasting Co., 30 Rockefeller Plaza, New York, N. Y.
Medkeff, D. D., 2114 Reading Rd., Cincinnati 2, Ohio
Merritt, N. A., R.F.D. 1, Noank Rd., Mystic, Conn.
Mitchum, M. M., Radio Station KTTR, Rolla, Mo.
Naybor, E. V., 53 Nassau Ave., Malverne, N. Y.
Parnes, J. J., 1922 Crotona Pkwy., Bronx 60, N.Y.
Quinn, C. E., 245 Glendale, Highland Park 3, Mich.
Rautio, R. W., 87 W. Loop, Port Clinton, Ohio
Richards, E. L., 1646 N. 73 Ct., Elmwood Park, Chicago, Ill.
Rodey, F. W., Jr., 1843 S. Ridgeland Ave., Berwyn, Ill.
Rupke, E., 1830 Independence Blvd., Ann Arbor, Mich.
Rusche, C. L. H., 5233 Petty St., Houston 7, Texas
Russell, W. H., 209 Eighth Ave., Haddon Heights, N. J.
Simpson, R. L., 2021 Kalorama Rd. N.W., Washington 9, D. C.
Smith-Vaniz, W R., Jr., 3903 Walnut Grove Rd., Memphis, Tenn.
Stewart, J., 398 Georges River Rd., Enfield, Sydney, N.S.W., Australia
Sund, H. E., Jr., 2316 Chelsea Terr., Baltimore 16, Md.
Sweeney, C. W., 827 N. 7 St., Camden, N. J.
Thomas, A. G., 1642 Mineral Spring Rd., Reading, Pa.
Thomas, W. D., Crawshay House, Highbridge Rd., Burnham-On-Sea, Somerset, England
Urman, B. S., 3550 Cochran Ave., Los Angeles 16, Calif.
Waller, S. L., Box 577, Howard Air Force Base, Canal Zone
Weaver, S. E., 35 Elm, Huntington, L. I., N. Y.
Webb, E. M. G., 4049 N. Sheridan Rd., Chicago 13, Ill.
Williams, C. E., 94½ Red River St., Austin, Texas
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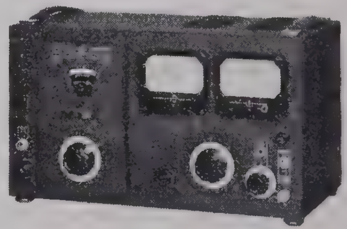

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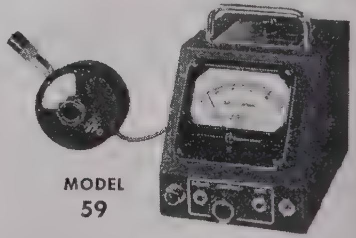

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CIRCULARS ON REQUEST

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

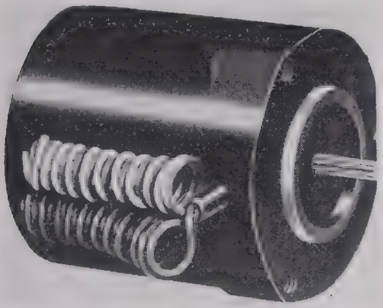
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 24A)

Miniature Drag Cup Motor

Two new products of **Kollsman Instrument Div., Square D Co.,** 80-08 45th Ave., Elmhurst, L. I., N. Y., are two miniature drag-cup motors. Generally used as follow-up motors, these instruments may serve as dynamometers for low-value torque measurements. They are also used in various control mechanisms to obtain variable speed and torque through voltage control. By simply having the motor apply a constant torque, objectionable backlash in a train of gears can be reduced.



Dimensions are: 7.6 ounces, 1.922″ length, 1.719″ diameter. There are two standard types: one develops 3000 r.p.m. and operates at 115 volts, 400 cps.

In both cases maximum stall torques of 0.32 to 0.41 ounce-inches are produced.

Custom motors for other voltages and frequencies can be supplied on order.

Plug-In Type DC Relay

Illustrated is the new Type "J" Relay manufactured by **C. P. Clare & Company,** 4719 West Sunnyside Avenue, Chicago 30, Illinois, It features independent twin contacts, high current carrying capacity, large armature bearing area, and is made with a standard octal base plug. Overall length of relay and plug is $3\frac{5}{8}''$. It is designed for installation where quick removal and easy replacement are desired, and is claimed to offer efficient magnetic structure, high operating speed and large contact spring pileups.

(Continued on page 48A)

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for *RADIO* and *Television* receivers . . .

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These spirally laminated paper base phenolic coil forms and tubes give exceptional performance with the added advantage of lower material costs. Note: We also have available numerous stock punching dies.

Partial list of Radio and Television Receivers in which Cosmalite is used:

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Your inquiry will receive immediate and intelligent attention.

Ask also about other Cosmalite types . . . #96 COSMALITE for coil forms in all standard broadcast receiving sets. SLF COSMALITE for permeability tuners. COSMALITE deflection yoke shells, cores and rings.

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Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

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- All-Fibre Cans • Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

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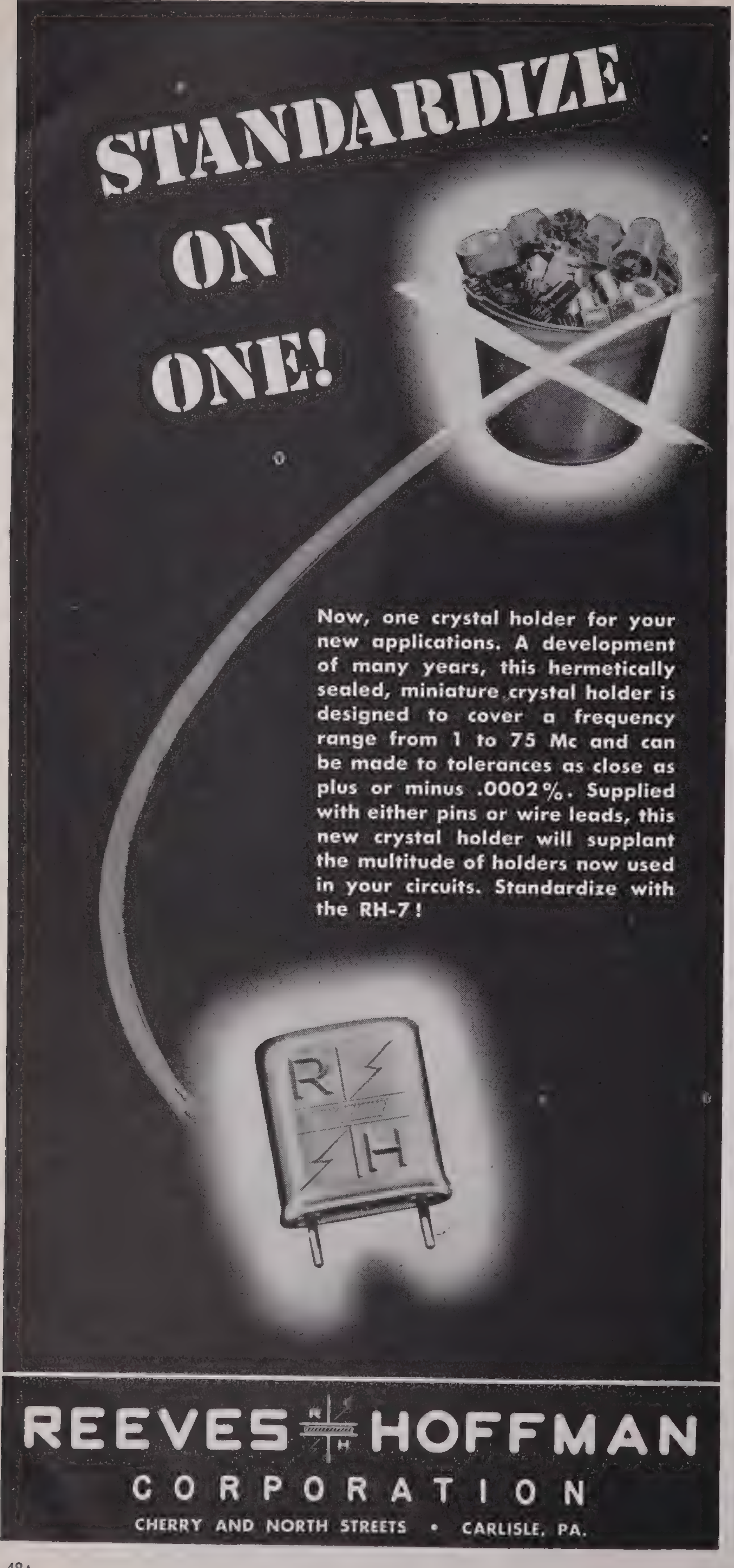
PRODUCTION PLANTS also at Plymouth, Wisc., Ogdensburg, N.Y., Chicago, Ill., Detroit, Mich., Jamesburg, N.J.
PLASTICS DIVISION at Plymouth, Wisc. • ABRASIVE DIVISION at Cleveland, Ohio
SALES OFFICES · Room 5832, Grand Central Term. Bldg., New York 17, N.Y., also 647 Main St., Hartford, Conn.
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario



Now, one crystal holder for your new applications. A development of many years, this hermetically sealed, miniature crystal holder is designed to cover a frequency range from 1 to 75 Mc and can be made to tolerances as close as plus or minus .0002%. Supplied with either pins or wire leads, this new crystal holder will supplant the multitude of holders now used in your circuits. Standardize with the RH-7!

REEVES-HOFFMAN
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CHERRY AND NORTH STREETS • CARLISLE, PA.

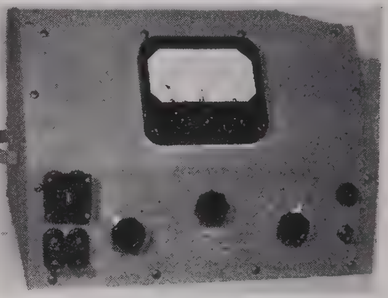
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 47A)

Wide-Frequency-Range Wattmeter

This new meter, designated as the Model 101 VAW, is in production by **Anderson-Fluke Engineering Co.,** Box 815 B, Springdale (Stamford), Conn.



The instrument is capable of measuring volts, amperes, and watts over a frequency range of 20 to 200,000 cps. Eight voltage ranges of 0.1 to 300 volts and ten current ranges of 0.001 to 30 amperes provide full-scale wattage readings of 100 microwatts to 9 kilowatts, giving the reading ranges of 1 to 60,000 for volts, 1 to 600,000 for amperes, and the extremely wide range of 1 to 1,800,000,000 for watts. The input resistance is 1 megohm in parallel with 25 $\mu\mu f$, and the full-scale shunt drop is only 5 millivolts. Powered by 117 volts, 60 cps, the electronically regulated power tupply and the feedback amplifiers result in exceptional stability of calibration.

The instrument is housed in an aluminum case 12″×12″×10″ high and weighs only 20 pounds. Accuracy is within 3 per cent on all scales. Literature available on request.

Recent Catalogs

• • • On nonfraying varnished tube **insulation**, and a product listing by **Insulation Mfrs. Corp.,** 565 W. Washington Blvd., Chicago 6, Ill.

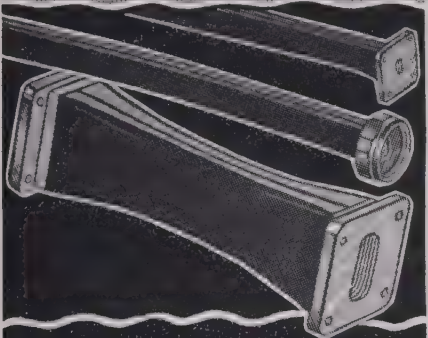
• • • On a leaflet explaining the construction and advantages of Tri-core "Leak-Pruf" acid-filled solder, by **Alpha Metals Inc.,** 363 Hudson Ave., Brooklyn 1, N. Y.

• • • On a tricolored 32-page catalog covering the thirteen major type series of multi-contact electric **connectors** for radio aircraft, communications, etc.; dc solenoids and signal equipment and miscellaneous products, by **Cannon Electric Development Co.** Humbolt St., and Ave. 33, Los Angeles 31, Calif. Request C-47 from Catalog Dept.

• • • On a 32-page booklet entitled "Stainless Plates (Solid and Clad) and their Fabrication," with charts, tables, and photographs designed to supply fabricators with late and authentic information on selection and fabrication of these products, by **Allegheny Ludlum Steel Corp.,** Pittsburgh 22, Pa.

(Continued on page 49A)

Airtron
FLEXAGUIDE



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FLEXIBLE MICRO-WAVE PLUMBING

Built to satisfy extreme flexing requirements. Specified and used in latest aircraft and shipboard applications. Useful in the elimination of standard rotary and swivel joints.

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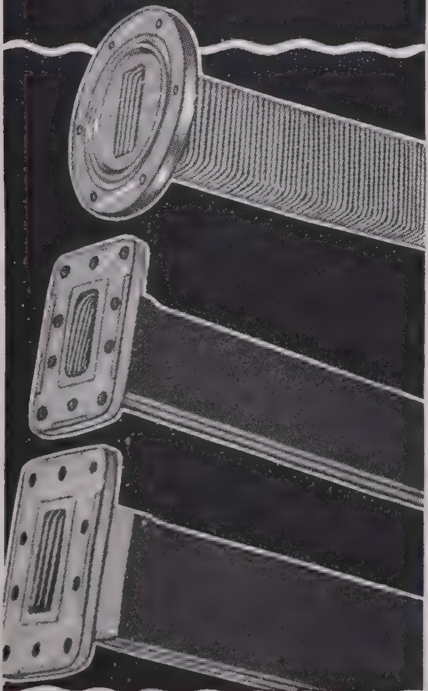


Airtron
DESIGNS and PRODUCES
Electronic and Aircraft Components
650 Bloomingdale Road, Pleasant Plains
Staten Island 9 New York
BRANCH OFFICES
Baltimore Detroit Los Angeles

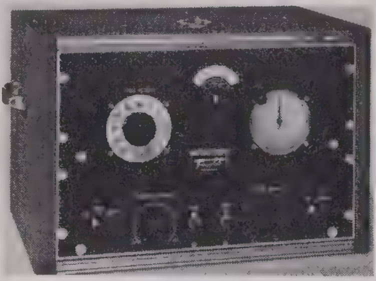
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

An Improved Autoscaler

A new-model improved Autoscaler, designated the SC-1A, with an extended range from 500 to 2200 volts; and regulated to 0.01% change in line voltage, is announced by **Tracerlab Inc.**, 55 Oliver St., Boston 10, Mass.



The SC-1A is a complete unit for supplying the operating voltage for a G-M tube, counting the impulses, and measuring the time required for collecting a given number of impulses.

When the preselected number of impulses has been determined, the timer automatically stops. There is no need to read neon interpolating lights, because a rapid, accurate reading of the timer is all that is necessary.

The over-all resolving time of the input amplifier and scaling circuits is approximately 5 microseconds. Pulse height sensitivity is approximately 250 millivolts. Also included with the SC-1A is a P-4 preamplifier suitable for use with either the plug-in type TGC-1/1B83 or TGC-2/1B84 Tracerlab Geiger tubes or those which require clip leads.

Interesting Abstract

New Servo Plant

Henry Blackstone, president of the **Servo Corp. of America**, 294 N. Fulton Ave., Lindenhurst, N. Y. has recently acquired space in the Wedemeyer Bldg., in New Hyde Park, L. I., N. Y. This expansion inaugurated Plant No. 2 of this company, and provides for increased production of their numerous products to the radio and electronic industry.

(Continued on page 57A)

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Problems are related to commercial and military aircraft and guided missiles. Employment is stable and offers opportunity for advancement to those able to assume responsibility. Present staff includes highly qualified physicists, engineers and mathematicians, and insures a stimulating professional environment. Imaginative and original design thinking is particularly encouraged. Liberal patent and publication policy. Apply through Personnel Manager, Boeing Airplane Company, Seattle 14, Washington.

TELEVISION ENGINEERS

The Crosley Division, Avco Manufacturing Corporation, is expanding its Television Receiver Activities on a long term basis, creating a few positions for qualified Supervisory and Senior Engineers.

Requirements: College Degrees. Three or more years experience in Television and Radar Design and Development of which at least two years have been spent in advanced or product development of television receivers. Specialists in circuit elements will be considered.

Ideal working conditions in well equipped modern laboratories with unlimited opportunities for advancement. Forty hour week, insurance, hospitalization and pension plans. Responsibilities and salary based on experience and ability.

Replies (which will be kept confidential) stating age, experience, education and salary requirements should be addressed to:

Director of Research and Engineering
Crosley Division—Avco Manufacturing Corporation
1329 Arlington St., Cincinnati 25, Ohio

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ....

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
I East 79th St., New York 21, N.Y.

TELEVISION ENGINEER

Chief Engineer of television broadcast station located in midwest city. Please state fully experience and qualifications. Box 516.

RADIO RECEIVER ENGINEERS

Radio Receiver Engineers. Various types of qualifications. Please state experience and salary requirements in first letter. Box 517.

ENGINEERS

Allen B. DuMont Laboratories, Inc. have several openings in their Clifton plant for Intermediate and Senior Engineers. Must have B.S. degree in physics or electrical engineering and experience in V.H.F., television deflection or general circuit development. Apply Personnel Dept., 1000 Main Ave., Clifton, New Jersey. 9:00 A.M. to 3:00 P.M.

ELECTRONIC DESIGN ENGINEER—PRODUCTION ENGINEER

(1) ELECTRONIC DESIGN ENGINEER—Boston firm developing electronic instruments for radioactivity detection and measurement. Offers excellent opportunity for high calibre design engineer. Write full details.

(2) PRODUCTION ENGINEER—Boston firm manufacturing electronic radioactivity instruments has opening for qualified man experienced in engineering production models from prototype designs. Position also entails responsibility for component and production quality control. Write full details. Box 518.

TELEVISION INSTRUCTOR

Television instructor wanted by a television training institution of long standing in Hollywood; must be well versed in the principles and practice underlying television transmitting and receiving. Minimum $3,200. State particulars, including educational and experience background. Box 521.

MATHEMATICIANS, ENGINEERS, PHYSICISTS

Men to train in oil exploration for operation of seismograph instruments, computing seismic data, and seismic surveying. Beginning salary—open depending upon background; excellent opportunity for advancement determined on ingenuity and ability. Nature of work requires several changes of address each year; work indoors and out; general locations in oil producing states. To apply, write giving scholastic and employment background, age, nationality, marital status and include recent snapshot to National Geophysical Co., Inc. 8800 Lemmon Ave., Dallas 9, Texas.

(Continued on page 52A)

Positions Wanted

(Continued from page 56A)

RADIO ENGINEER

Radio Engineer, currently employed in commercial engineering division of metropolitan tube manufacturer, desires change to permanent position in midwest. Age 27, married, 1 child. B.S. physics, graduate Army Electronic Training Center, M.I.T., Harvard, 3 years military experience, special roving radar officer US and ETO, 2 years commercial circuit work in present position. Minimum salary $5,500. Box 184 W.

ENGINEER

B.S.R.E. August 1948. Age 24. Married, 1 child. 3 years U. S. Navy electronics technician. 2nd class Radio Telephone. Considerable servicing experience. Desires position with opportunity for advancement. Box 185 W.

JUNIOR ELECTRONIC ENGINEER

B.E.E. June 1948. Cornell University (Top third of class). Two years Navy experience as electronics technician, including 8 months sea duty with responsibility. Seeking permanent position with opportunity, preferably within commuting distance of New York City. Box 186 W.

SALES ENGINEER OR EXECUTIVE ASSISTANT

Young, aggressive, hard-hitting design and development engineer invites inquiries from firms having need for addition to sales engineering staff or assistant to top executive. Thorough background of research design and supervision in measurement apparatus, receivers, transmitters and audio equipment. Capable of handling engineering, purchasing, production, inspection and personnel. Prefer New York City location. Box 187 W.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 49A)

Recent Catalogs

• • •On up-to-the-minute facts and figures which have been compiled on the use of stainless steels in a booklet entitled "Allegheny Metal in Chemical Processing," by **Allegheny Ludlum Steel Corp.,** 2020 Oliver Bldg., Pittsburgh 22, Pa.

• • •On many practical applications, and arguments for the use of magnesium, in "The Magazine of Magnesium," by **Brooks & Perkins Inc.,** 2457 Woodward Ave., Detroit 1, Mich.

• • •On a self-starting synchronous timing motor, in Bulletin No. 10A, by the **R. W. Cramer Co. Inc.,** Centerbrook, Conn.

(Continued on page 58A)

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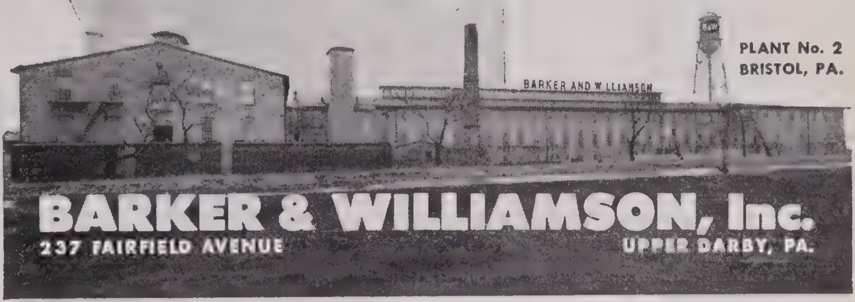
COMPLETE RADIO TRANSMITTERS • DUAL DIVERSITY CONVERTERS, CONTROL UNITS and FREQUENCY SHIFT EXCITERS FOR RADIO TELETYPE TRANSMISSION • SPECIAL TEST EQUIPMENT • REDESIGN, MODERNIZATION AND MODIFICATION OF EXISTING EQUIPMENT • MACHINE WORK • METAL STAMPING • COILS • CONDENSERS • OTHER ELECTRONIC DEVICES IN A WIDE RANGE OF TYPES

From small electronic components up to carefully engineered test equipment and complex electronic devices, Barker & Williamson can engineer and manufacture high quality products to your specifications.

Three B&W plants, comprising 150,000 square feet, completely equipped with a competent engineering staff, machine shop, tool room (including all machines for drilling, milling, turning, stamping and forming metals and plastics), and a complete woodworking shop are at your disposal. Your inquiries are welcome. Write Department PR 88 . . . for prompt reply.



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FM SIGNAL GENERATOR
MODEL 202-B

FREQUENCY RANGE
54 to 216 MEGACYCLES

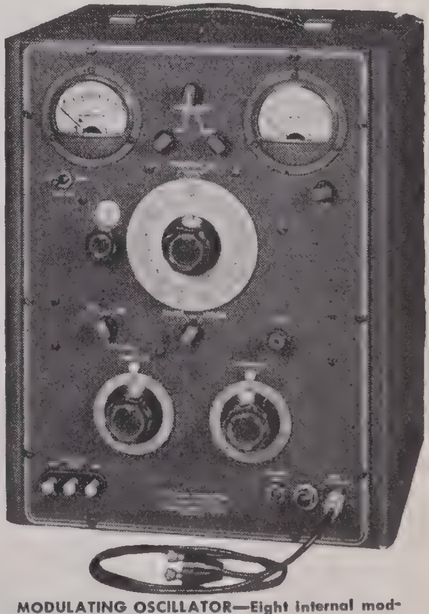
The model 202-B is specifically designed to meet the needs of television and FM engineers working in the frequency range from 54-216 mc. Following are some of the outstanding features of this instrument:

RF RANGES—54-108, 108-216 mc. ± 0.5% accuracy.

VERNIER DIAL—24:1 gear ratio with main frequency dial.

FREQUENCY DEVIATION RANGES—0-80 kc; 0-240 kc.

AMPLITUDE MODULATION—Continuously variable 0-50%; calibrated at 30% and 50% points.



MODULATING OSCILLATOR—Eight internal modulating frequencies from 50 cycles to 15 kc., available for FM or AM.

RF OUTPUT VOLTAGE—0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.

FM DISTORTION—Less than 2% at 75 kc deviation.

SPURIOUS RF OUTPUT—All spurious RF voltages 30 db or more below fundamental.

Write for Catalog D

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THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
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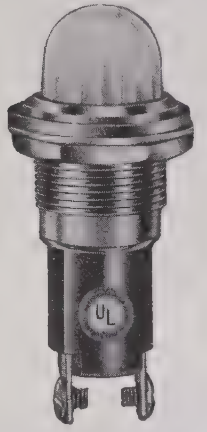
DIALCO

PILOT LIGHT ASSEMBLIES

PLN SERIES—Designed for NE-51 Neon Lamp



Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
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- EXTREME RUGGEDNESS
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Used effectively in leading laboratories, such as: Harvard University, Bell Aircraft Corp., and Hamilton Standard Propellers . . . for measuring natural frequencies or speed of rotating objects, checking or calibrating tachometers, oscillators, impulse generators, similar equipment.

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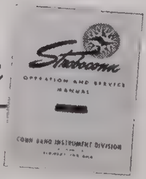


Please send *free* Strobocon folder containing information about operation and application of this new precision instrument. I understand this places me under no obligation.

Name________ Position________
Company________
Address________
City________ Zone____ State________

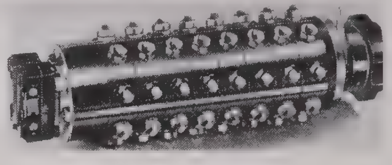
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 57A)

Rotary Tap Switch

The Tesco Rotary Tap Switch has been developed by the **Eastern Speciality Co.,** Philadelphia 40, Pa., for use in circuits whose requirements cannot be fully met by existing types of switches.



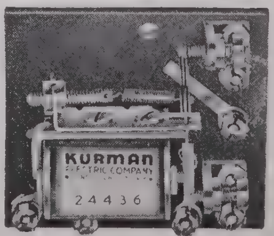
Each switch section, with seven active positions and one off position, is rated at 50 amperes continuous duty, with an overload capacity of 75 amperes. As many as twelve switch sections in tandem may be operated in parallel to handle a maximum current of 600 amperes.

A current interrupter consisting of one or two microswitches, rated at 10 amperes, and operated by the detent action, opens the source of power when the switch is rotated toward a new position, so that no arcing occurs at the switch contacts. Due to this nonarcing feature, the circuit in which the switch is used may be at high voltage, carrying an inductive load.

Individual switch sections measure 2½″ diameter over the housing, 3¼″ over the terminal studs, length ¾″. Request Bulletin No. 57 for complete operating data.

Sensitive Relay with Split Armature

A relay with a split armature classified as the "24" is now on the market from **Kurman Electric Co.,** 35-18 37th St., Long Island City 1, N. Y.



Used for automatic controls, keying antenna changeover, burglar alarms, and closed-circuit applications, this relay has a rated sensitivity of 0.014 watts dc. or 0.3 va ac. It adjusts to operate at 0.005 watts, and from 0.01 to 115 volts dc or ac.

(Continued on page 59A)

PROFESSIONAL CARDS

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News—New Products

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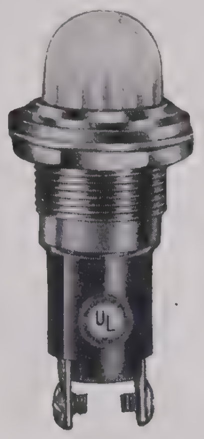
(Continued from page 58A)

"Multivue" Cap Pilot Light Effective with Neon Lamp

A new type of pilot light with a "Multivue" cap, which is said to be highly effective with neon lamps, in being manufactured by **Dial Light Co. of America, Inc.**, 900 Broadway, New York 3, N. Y.



Primarily intended to obtain new effectiveness for the NE-S1 neon glow lamp, a radically new principle was employed. Instead of being scattered by facets or concentrated by a lens, the light from the glowing electrodes is refracted in such a way that a multiple image is seen from any viewing angle.

The necessary resistor for the lamp is built in. With voltages of 110 or 220 or higher a small additional resistor must be included.

Powerful Rotary Solenoids

Two powerful Ledex rotary solenoids are now being produced by **G. H. Leland, Inc.**, 135 Webster St., Dayton 2, Ohio.

The Ledex No. 7 is $2\frac{3}{4}''$ in diameter, weighs less than $2\frac{1}{2}$ lbs, and develops a starting torque of 25 pound-inches with a 45° rotary stroke.

(Continued on page 60A)

Attention
Associate Members!

Many Associate Members can qualify for higher membership grades and should certainly do so. Members are urged to keep membership grades up in pace with their present development.

An Associate over 24 years of age who is occupied as a radio engineer or scientist, and is in this active practice three years may qualify for Member Grade.

An Associate who has taught college radio or allied subjects for three years may qualify.

Some may possibly qualify for Senior Grade. But transfers can be made only upon your application. For fuller details request transfer application-form in writing or by using the coupon below.

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Please send me the Transfer Application Membership-Form.

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STATION WHKC ...Selects TECH LABS
VERTICAL ATTENUATORS
for new CONSOLE INSTALLATION

The flick of a finger operates the patented "Gove" Vertical Attenuator. Representing the very latest in broadcast components, these units are suitable for every type of sound equipment from elaborate broadcast stations to the simplest P.A. system. Unit gives smooth easy operation and can be cleaned from front of panel by removing escutcheon. Completely shielded and dust proof.

Courtesy of WHKC,
United Broadcasting Co.

Write for Descriptive Bulletin

TECH LABORATORIES, INC.
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

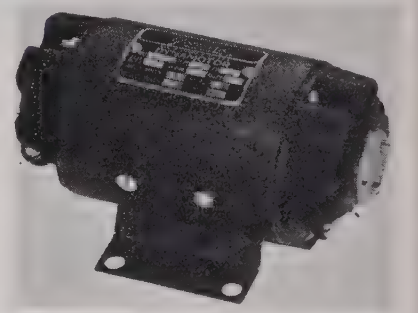
(Continued from page 59A)

The Ledex No. 8 is 3⅜″ in diameter, weighs slightly over 4 lbs, and develops a starting torque of 50 pound-inches with a rotary stroke similar to the No. 7. Both units are of similar construction.

A choice of wire sizes from Nos. 13 to 35 represents dc operation from 6 to 550 volts.

Dynamotor for Mobile Transmitters

A new type of dynamotor, developed in the laboratories of **Gothard Mfg. Co.,** 2110 Clear Lake Ave., Springfield, Ill., is now being marketed.



Styled as Model GP-26, its primary use is for mobile transmitters, but it is also suited to many marine and aircraft applications.

This model is available in a range of capacities to meet various requirements, with power output ranging up to 80 watts continuous duty, and 150 watts intermittent duty. Voltage regulation averages 19%, with the unit efficiency about 61%.

Dimensions are: height, 4″, length 7½″, frame diameter 3½″, weight, 8½ lbs.

Recent Catalogs

• • • An illustrated 24-page catalog, listing over 400 Stancor stock items, and various charts on transmitting tubes, driver-modulator combinations, and matched power supplies, by **Standard Transformer Corp.,** Elston, Kedzie and Addison Sts., Chicago 18, Ill. Request Catalog 140-H from Dept. K.

• • • Bulletin No. 133, which describes the Model 450 series hi-meg multitesters, by **Radio City Products Co.,** 152 W. 25 St., New York 1, N. Y.

• • • A wall chart which gives a complete selection of resistors, controls, and resistance devices by **Clarostat Mfg. Co., Inc.,** 130 Clinton St., Brooklyn 2, N. Y.

• • • On a new liquid wire stripper, "Formula 21", for removing Formex, Formovar, enamel, and similar wire insulating coatings, request catalog section 71, **Aircraft Marine Products Co.,** 1613 N. 4th St., Harrisburg, Pa.

(Continued on page 61A)

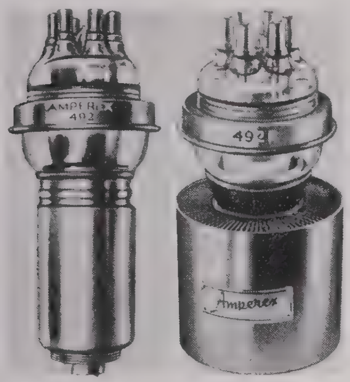
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

5-Kw Air-Cooled and Water-Cooled Triodes

Two new high-frequency triode amplifier and oscillator tubes, one water-cooled and one air-cooled, have been announced by **Amperex Electronic Corp.**, 79 Washington St., Brooklyn 1, N. Y.



The maximum rating of 5 kw plate dissipation applies up to a frequency of 150 Mc. The 492-R radiator is capable of dissipating full power with an air flow of 170 cfm. The 492 anode is capable of dissipating 5 kw of power with a water flow of 3 to 5 gallons of water per minute. The water jacket is an integral part of the tube, and a separate adaptor is provided for connection to external water lines. For high-frequency coaxial circuits, the water jacket is readily adaptable for extension into standard 2" copper tubing of any desired length to permit adjustment for a particular frequency.

Television Components Made Available by GE

A new line of television components, for use with 10" picture tubes requiring 50° magnetic deflection at an accelerating voltage of 9000 volts, has been announced by the **Receiver Division of the General Electric Co.**, Electronics Park, Syracuse, N. Y.

The components consist of a horizontal output transformer, horizontal size control, horizontal linearity control, deflection yoke, focus control, centering device, mounting bracket, and ion trap.

The permanent-magnetic centering device is the only one on the market today, according to R. S. Fenton, sales manager for the division's component parts section. The focus coil is a combination of permanent and electromagnets, and the horizontal transformer is polyethylene molded and hermetically sealed. The new ion trap may be slipped on to the tube without removal of the socket.

Over-all length of the deflection yoke, centering device, and focus coil assembly is $4\frac{3}{16}''$. Maximum diameter of the assembly is $3\frac{1}{2}''$.

(Continued on page 62A)

NEW . . .

High Precision 2-inch Potentiometer

Designed to meet the high standards demanded by computer and military applications

Mechanical Specifications

- Precision machined aluminum base and cover 2" diameter, 1" deep.
- Precision phosphor bronze bushings.
- Centerless ground stainless steel shaft.
- No set screws.
- Mechanical rotation—360°.
- Basic design permits use in ganged assemblies.

Electrical Specifications

- Winding—both linear to 0.5% and non-linear to 1% accuracies.
- Paliney contact to winding; two-brush rotor take-off assembly with precious metal contacts.
- High, uniform resolution provided by our method of winding non-linear resistances.
- Electrical rotation maximum 320°.
- All soldered connections (except sliding contacts).

This general line of precision potentiometers was developed in collaboration with the Fire Control Section of the Glenn L. Martin Company.

Send us detailed information on your requirements for prompt quotation on large or small quantities.

TECHNOLOGY INSTRUMENT CORP.
1058 MAIN STREET, WALTHAM 54, MASS.
Midwest Office: Alfred Crossley & Associates, 549 W. Randolph St., Chicago 6, Illinois, State 7444

Only with CO-AX
4mmf/ft
Patents Regd. Trade Mark

air-spaced articulated
R.F. CABLES

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to handle direct enquiries from overseas and can give

IMMEDIATE DELIVERIES FOR EXPORT

Write or cable for data sheets or deliveries to the Originators of flexible air-spaced R.F. Cables

LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft at 100 Mc/s.	LOADING Kw at 100 Mc/s.	O.D."
A 1	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

HIGH POWER FLEXIBLE

LOW CAPAC TYPES	CAPAC mmf/ft.	IMPED OHMS	ATTEN db/100ft 100Mc/s.	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.1	1.03

PHOTOCELL CABLE

V.L.C. ★

★ *Very Low Capacitance cable*

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD·LONDON SW7 ENGLAND
CABLES: TRANSRAD. LONDON.

How to Solder Around Corners... and Between Wiring...

FLEXITIP—loop tip easily formed—no retinning.
LONGER-REACH—8" from housing to tip; gives greater reach.
BUILT-IN TRANSFORMER — compact, complete and safe.
5 SECOND HEATING — no waiting; saves power.
SOLDERLITE—spotlights the work.
DUAL HEAT—single heat 100 watts, dual heat 100/135 watts, 110 volts, 60 cycles.

Here's a tip from Weller—a *Flexitip* that is, attached to a "longer-reach" Weller Soldering Gun. Form that flexible loop tip into any shape you want and see how it slides around corners, between wiring, into the tightest spots. Even when the job's buried deep, Flexitip and the 8" Weller Gun will reach it.

But that isn't the only advantage of the Weller Soldering Gun. Just check the 6 features and see why it's called the "handful of soldering convenience."

Solderlite and 5-second heating means hours and dollars saved—your Weller Gun will pay for itself in a few months. And because the transformer is built in—not separate—the Weller Gun is a complete, compact unit, safer and easier to use. There's no need to unplug the gun when not in use; heat comes "on" only when the trigger is pulled.

For laboratory and maintenance work, we recommend the efficient 8" model—DX-8 with dual heat; or 4" types S-107 single heat and D-207 dual heat. Order from your distributor or write for bulletin direct.

WELLER MFG. CO.

821 Packer Street • Easton, Pa.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 61A)

Wherever possible, permanent magnets supply the dc magnetic fields in the components, eliminating much of the wiring and space consideration normally given to these parts.

Recent Catalogs

• • • A new 4-page catalog covering the company's "Time-Saver Templates" for engineers, designers, draftsmen, and architects, by **Rapidesign Inc.**, P.O. Box 592, Glendale, Calif. Each type of template is pictured, designated by number and briefly described. Copy may be obtained from address given above.

• • • A television control replacement manual which will be made available to firms writing on their business stationery, by **Clarostat Mfg. Co.**, 130 Clinton St., Brooklyn 2, N. Y.

• • • A product list of electrical insulating materials, by **Insulation Mfrs. Corp.**, 565 W. Washington Blvd., Chicago 6, Ill.

• • • A 7-page catalog describing standard microwave equipment and components, by **Waveguide Mfg. & Equipment Co., Inc.**, 125 E. 23 St., New York 10, N. Y.

• • • Folder CX39A describes filter engineering that has opened up new spectrum space for use either as a narrow-band voice circuit, or with a nine-channel FM or AM telegraph system specially designed for this application, by **Lenkurt Electric Co.**, 1134 County Rd., San Carlos, Calif.

• • • Three new bulletins of interest to the recording and broadcast fields: (1) Bulletin No. 139, on improved Cardyne cardioid dynamic microphones; (2) Bulletin No. 140 on replacement "Mobil-Mikes" for Motorola, RCA, GE, and similar communications equipment; (3) Bulletin No. 141 on a new torque-drive crystal pickup cartridge, by **Electro-Voice, Inc.**, Buchanan, Mich.

• • • A catalog describing a new line of custom-engineered automatic voltage stabilizers, for precise ac line-voltage stabilization, by **Raytheon Mfg. Co.**, 60 E. 42 St., New York 17, N. Y.

• • • A description of a new high-speed general-purpose electronic computor, entitled, "The UNIVAC System," by **Eckert-Mauchly Computer Corp.**, Broad and Spring Garden Sts., Philadelphia 25, Pa.

• • • On a line of resistors, rheostats, and relays; catalog D-130, by the **Radio & Electronic Distributor Div., Ward Leonard Electric Co.**, 53 W. Jackson Blvd., Chicago 4, Ill.

• • • A concise 4-page illustrated booklet, No. CDM-16, describes GE permanent-magnet sub-assemblies; by the **Metallurgy Div., General Electric Co.**, Pittsfield, Mass.

Kahle

ELECTRON TUBE MACHINERY OF ALL TYPES
STANDARD AND SPECIAL DESIGN

• • • • • • • • • • •

We specialize in Equipment and Methods for the Manufacture of

RADIO TUBES
CATHODE RAY TUBES
FLUORESCENT LAMPS
INCANDESCENT LAMPS
NEON TUBES
PHOTO CELLS
X-RAY TUBES
GLASS PRODUCTS

Production or Laboratory Basis

Manufacturers contemplating New Plants or Plant Changes are invited to consult with us.

KAHLE
ENGINEERING COMPANY
1315 SEVENTH STREET
NORTH BERGEN, NEW JERSEY, U. S. A.

WANTED

ELECTRONIC ENGINEERS AND PHYSICISTS

Excellent opportunities for graduates with research, design, and/or development experience in Communications and aerial navigation systems including direction finders, radar, FM, television, micro-wave.

Write complete details regarding education, experience and salary desired.

To personnel manager

Federal Telecommunication Laboratories

500 Washington Ave.

Nutley, New Jersey

AM · FM · TV
RAYTHEON SPEECH EQUIPMENT

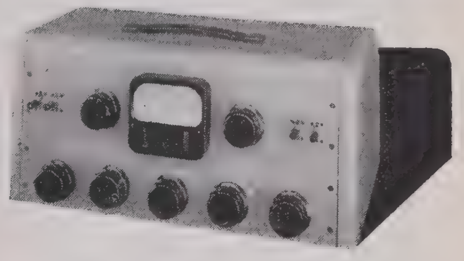
For the last word in complete, up-to-the-minute facilities
. . . or simple, low-cost equipment to suit your limited requirements . . .

Look to RAYTHEON for All Your Needs

RC-11 STUDIO CONSOLE

NOW WITH CUE POTS FOR TWO TURNTABLES

Provides complete high-fidelity speech input facilities with all control, amplifying and monitoring equipment in one cabinet. Seven built-in pre-amplifiers, nine mixer positions, cue attenuators for two turntables. Simple, positive controls reduce operational errors. Frequency response—2 DB from 30 to 15,000 cycles; Distortion—less than 1% from 50 to 10,000 cycles; Noise Level—minus 65 DB's or better. Meets all FCC requirements for FM.

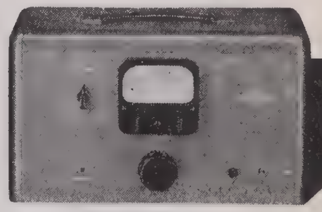


RPC-40 PORTABLE CONSOLETTE

Ideal for remote pickups yet complete enough to serve as a studio console. Four input channels for microphones or turntables, high level mixing, two output lines. Two RPC-40's interconnected provide 8-channel mixing—a feature of special interest to new TV stations planning future expansion.

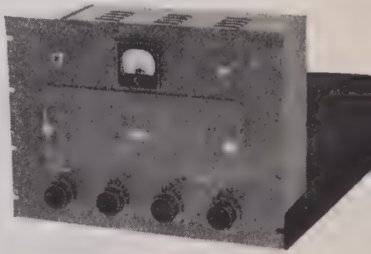
RR-30 REMOTE AMPLIFIER 3 CHANNEL

A lightweight, easy-to-carry combination of amplifier and power supply—simple and quick to set up. Provides three high-fidelity channels, excellent frequency response, high over-all gain.



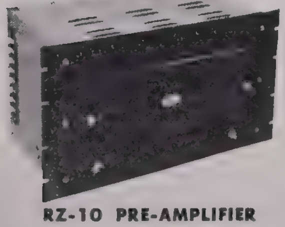
RR-10 REMOTE AMPLIFIER SINGLE CHANNEL

A complete, self-contained unit with built-in power supply. An excellent low-cost amplifier for remote pickups requiring only one high-fidelity channel.



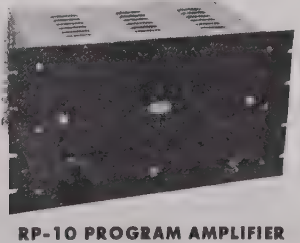
RL-10 VOLUME LIMITER

Engineered for high-fidelity AM, FM or TV speech input. Increases average percentage modulation without distortion.



RZ-10 PRE-AMPLIFIER

A plug-in type pre-amplifier or booster for microphones or turntables. Handles high input level. Noise level below 85 db from 0 vu output. Low distortion. Plug-in construction permits using one to four units for maximum flexibility.



RP-10 PROGRAM AMPLIFIER

A high-fidelity, single-unit amplifier and power supply. Over-all gain, 65 db; frequency response flat from 30 to 15000 cps; distortion less than 2% at + 30 vu. Designed for rack or cabinet mounting.

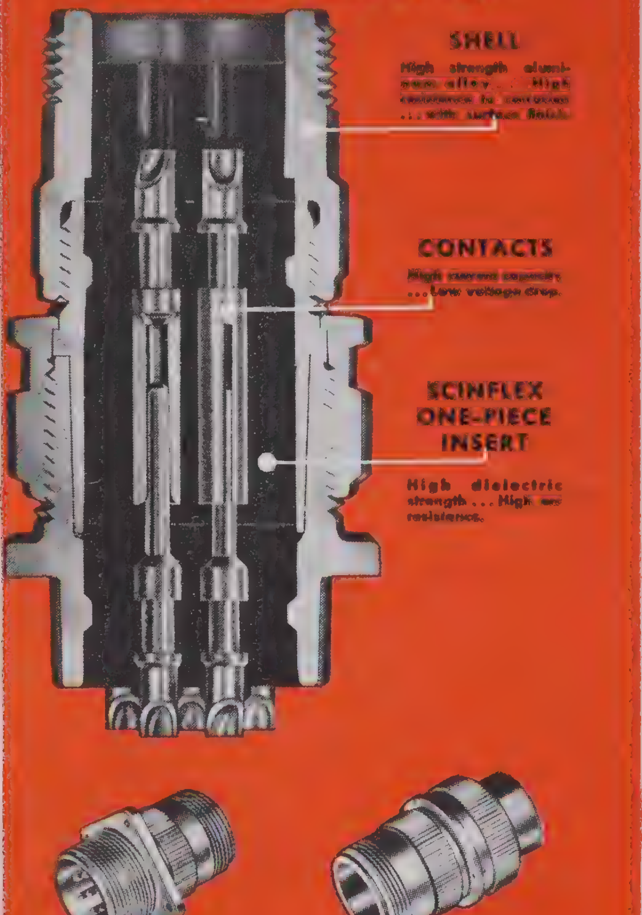
RPL-10 LINE AMPLIFIER

A single-control, two-stage amplifier featuring wide frequency response, low distortion, low noise level, freedom from RF pickup. Push-pull throughout. Mounts in standard rack or cabinet.

RAYTHEON MANUFACTURING COMPANY
WALTHAM 54, MASSACHUSETTS

EXPORT SALES AND SERVICE IN FOREIGN COUNTRIES
Raytheon Manufacturing Company
50 Broadway, New York 4, N. Y., WH. 3-4980

BENDIX-SCINTILLA
the finest ELECTRICAL CONNECTORS
money can build or buy!


SHELL
High strength aluminum alloy ... High resistance to corrosion ... with surface finish.
CONTACTS
High current capacity ... Low voltage drop.
SCINFLEX ONE-PIECE INSERT
High dielectric strength ... High arc resistance.

AND THE SECRET IS SCINFLEX!

Bendix-Scintilla* Electrical Connectors are precision-built to render peak efficiency day-in and day-out even under difficult operating conditions. The use of "Scinflex" dielectric material, a new Bendix-Scintilla development of outstanding stability, makes them vibration-proof, moisture-proof, pressure-tight, and increases flashover and creepage distances. In temperature extremes, from —67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil.

The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—an exclusive feature that means lower maintenance cost and better performance.

*REG. U.S. PAT. OFF.

Write our Sales Department for detailed information.

• Moisture-proof, Pressure-tight • Radio Quiet • Single-piece Inserts • Vibration-proof • Light Weight • High Arc Resistance • Easy Assembly and Disassembly • Less parts than any other Connector

Available in all Standard A.N. Contact Configurations

BENDIX SCINTILLA
SCINTILLA MAGNETO
SIDNEY, N. Y.
DIVISION OF
Bendix
AVIATION CORPORATION

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

New Electrolytic Capacitors

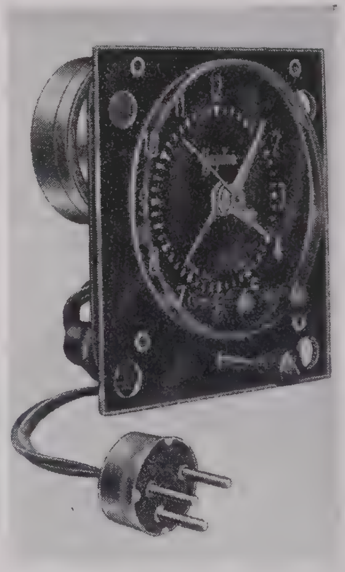
A new line of electrolytic capacitors designed specifically for television requirements has just been announced by **Sprague Electric Co.,** North Adams, Mass.

The new units are rated for dependable operation at 85°C up to 450 volts.

The manufacturer claims that as a results of improved processing techniques developed by their research and development engineers, and new manufacturing facilities, the units have an extended shelf life.

Radio Alarm Clock

The addition of a new radio alarm clock to its line of timing motors and devices has been announced by **The Haydon Manufacturing Co., Inc.,** of Torrington, Connecticut.



The new design is a combination clock and control for mounting on panels. The clock is complete with hour, minute, and sweep-type second hands. It has a three-position switch for turning the radio "on," "off," or for setting the radio to turn "on" at a preselected time, as indicated by a red alarm hand. The manufacturer states that the clock may be mounted in any position and that no shielding is required to prevent interference with radio reception.

When in the "alarm" position the length of radio play is limited to one hour and fifteen minutes. The user may therefore leave the radio without turning it off.

All controls for this device are grouped at the base of the clock. The unit can be supplied with or without cord or plug and in finishes to the buyer's specification, in production quantities only.

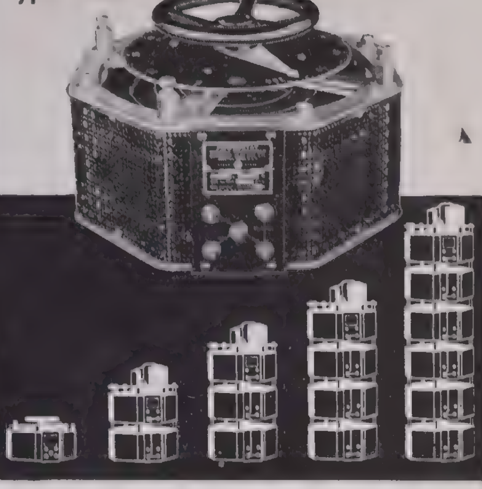
(Continued on page 40A)

POWERSTAT

VARIABLE TRANSFORMERS

FOR HEAVY DUTY

POWERSTAT
Type 1256



POWERSTAT variable transformers are not limited to laboratory, test panel or low power applications. As single units or as ganged assemblies, POWERSTAT types 1156 and 1256 provide smooth, precise, continuously adjustable variable a-c voltage for heavy duty requirements.

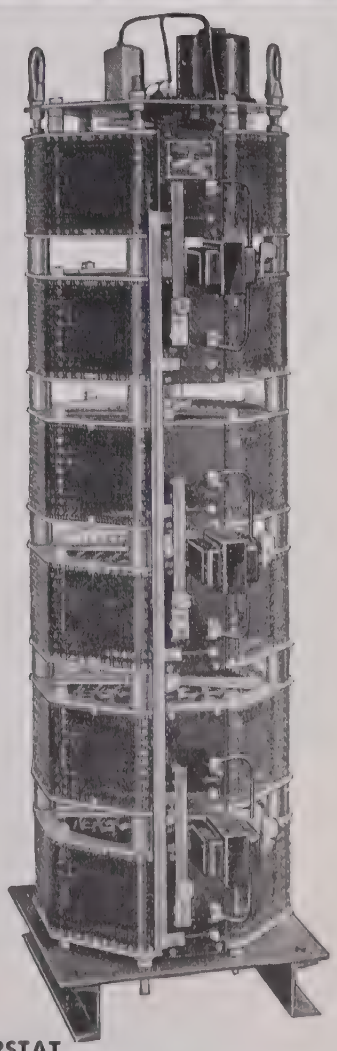
Type 1156 operates from a 115 volt, single phase, 50/60 cycles source to deliver 0-135 volts, 45 amperes output. Type 1256 delivers a variable output of 0-270 volts, 28 amperes from a 230 volt, single phase, 50/60 cycles line.

To obtain higher single phase ratings, types 1156 and 1256 are series, parallel or parallel-series connected, in ganged assemblies of 2, 3, 4 and 6 — operating on a common shaft. POWERSTATS in this arrangement can be supplied in 115, 230 or 440 volt ratings with output currents as high as 270 amperes. Three phase units are available in the same ratings. As many as 18 individual POWERSTAT types 1156 or 1256 can be employed in a three phase assembly. Type 1256-18Y (18 POWERSTATS with a single control) delivers 0-515 volts, 168 amperes from a 440 volt, three phase 50/60 cycles source.

Motor drive is recommended for heavy duty POWERSTATS. It gives finger-tip operation from a conveniently located push-button station, with the same smooth control found in the smallest manually-operated unit.

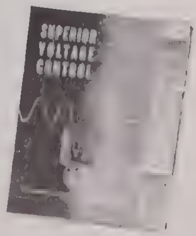
Whether your variable voltage requirement is 1 or 150 KVA, there's a POWERSTAT variable transformer to do the job.

The Superior Electric Co., 809 Meadow St., Bristol, Conn.



POWERSTAT
Type MW 1156-6Y

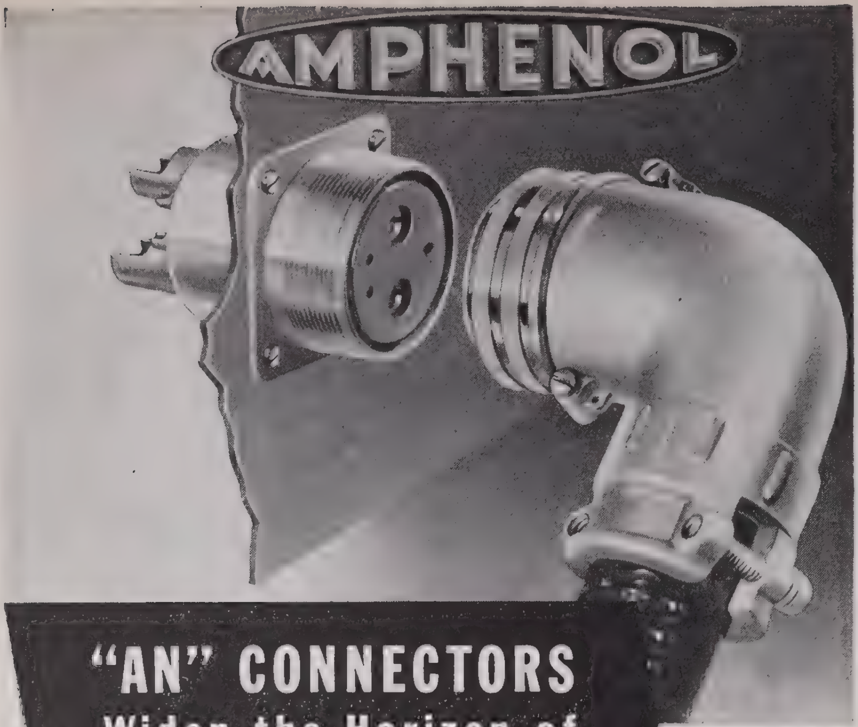
THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT



Superior Electric catalog — Bulletin 547 — is yours for the asking. Write today.

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLY • STABILINE VOLTAGE REGULATORS

AMPHENOL



"AN" CONNECTORS
Widen the Horizon of
Industrial Electronics

Wherever industrial electronic equipment is sectionalized, Amphenol AN connectors serve with efficiency and economy to provide quick connection and easy disconnect for servicing or movement.

They save money by permitting associated wiring for one or many circuits to be prefabricated, thus electronic devices may be tested at the factory and instantly connected for use on arrival. This greatly simplifies installation and servicing procedures.

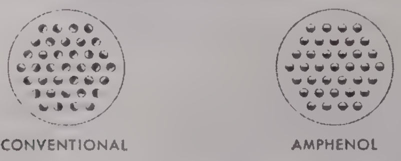
Available in five major shell designs, each of which accommodates over 200 styles of contact inserts, Amphenol AN connectors handle voltages up to 22,000, amperages up to 200. Types with pressure-proof, explosion-proof or moisture-proof housings also are available, as are standard elements for thermocouples.

The complete new Amphenol "AN" catalog is just off the press. A note on your letterhead will bring a copy immediately.

AMERICAN PHENOLIC CORPORATION
1830 South 54th Avenue, Chicago 50, Illinois
COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

AMPHENOL NON-ROTATING, ALIGNED CONTACTS

AMPHENOL



A typical example of outstanding Amphenol design:—All Amphenol solder pockets face in one direction—easy to set in a fixture—easy to solder—will not twist or turn—ideal for low-cost, efficient production. Only one of a dozen important features.

SECTION MEETINGS

Baltimore

"Printed Circuits and Miniature Electronics," by C. Brunetti, United States Bureau of Standards; June 22, 1948.

Election of Officers; June 22, 1948.

Buenos Aires

Election of Officers; April 16, 1948.

"Airport Communications Systems," by P. C. Sandretto, Internation Telecommunications Laboratory; May 21, 1948.

"Class-C Amplifiers," by M. Castellani; June 3, 1948.

"RF Heating Applications," by N. L. Pigache; June 18, 1948.

"Television in Argentina," by J. P. Calvelo; July 1, 1948.

Des Moines-Ames

"Microwaves—Their Peacetime Applications," by C. D. Peebler, Northwestern Bell Telephone Company; June 17, 1948.

"Radar Landing of Airplanes," by L. W. Von Tersch, Iowa State College; June 17, 1948.

Detroit

"The Ear as an Acoustical Instrument," by V. Salmon, The Jensen Manufacturing Company; May 21, 1948.

Houston

"A Visual Indicating Phasemeter," by W. C. Welz, Schlumbreger Well Surveying Corporation; June 16, 1948.

"Electronic Well Logging Thermometer and Its Applications," by H. C. Waters, Halliburton Oil Well Cementing Company; June 16, 1948.

"The Section's Activity for 1947," by C. N. Cutler, Secretary of Buenos Aires Section; April 16, 1948.

Kansas City

"Television—Its Mechanism and Promise," by W. L. Lawrence, Radio Corporation of America; May 6, 1948.

Election of Officers; May 18, 1948.

Philadelphia

"Projection Television Receiver Design Features," by E. Clark, Victor Radio Corporation of America; May 6, 1948.

Election of Officers; May 6, 1948.

Sacramento

"Stub Matching of RF Transmission Lines," by W. E. Evans, Jr., McClatchy Broadcasting Company; June 15, 1948.

Election of Officers; June 15, 1948.

San Diego

"Recent Design in Magnetic Recording," by R. Callen and M. Frank, United States Navy Electronics Laboratory; June 8, 1948.

"Transmission of Electromagnetic Energy in a Dissipative Media," by S. A. Schelkunoff, Bell Telephone Laboratories and New York University; July 13, 1948.

Interesting items of industrial news and new products appear on pages 24A and 40A etc. Items of this sort are invited when of genuine engineering interest.

ALPETH

NEW WORD ON

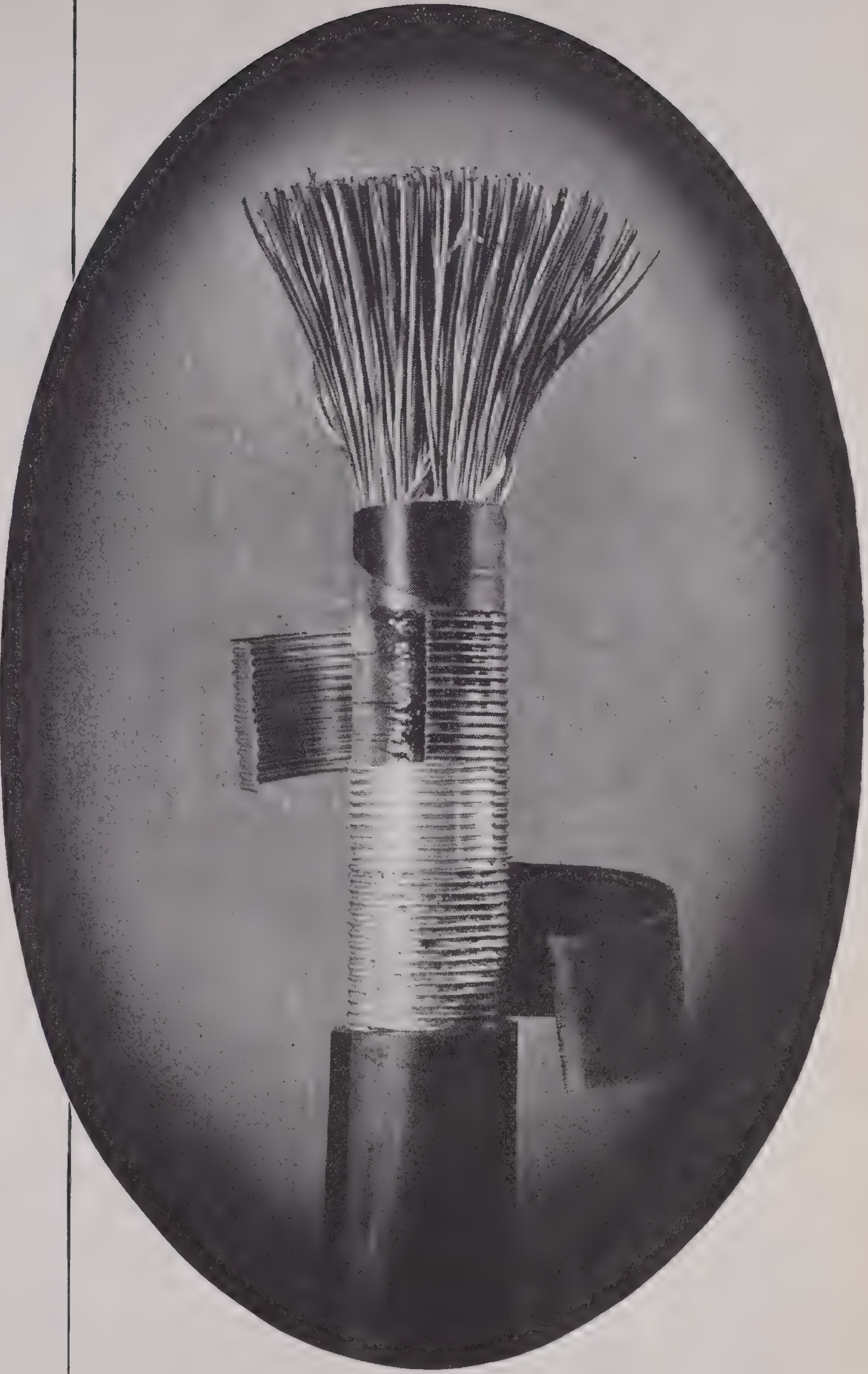
TELEPHONE CABLES

Lead makes an excellent sheath for telephone cables—sixty years and thousands of miles in service have well proven that. But lead is useful in other ways—storage batteries and paint, to name only two. So the telephone industry shares the limited available supply with other claimants.

Before the war when there was no lead shortage, Bell Laboratories engineers sought to develop better and cheaper cable sheaths. An ideal sheath is strong, flexible, moisture-proof, durable and must meet specific electrical requirements. No single material had all those virtues, so thoughts turned to a composite sheath, each element of which should make a specific contribution to the whole.

Various materials and combinations were studied. Desirable combinations that satisfactorily met the laboratory tests were made up in experimental lengths, and spent the war years hung on pole lines and buried in the ground. After the war, with an unparalleled demand for cable and with lead in short supply, selection was made of a strong composite sheath of *AL*uminum and Poly*ETH*ylene. Now Western Electric is meeting a part of the Bell System's needs with "*ALPETH*" sheathed cable.

Meeting emergencies—whether they be storm, flood or shortage of materials—is a Bell System job in which the Laboratories are proud to take part.



BELL TELEPHONE LABORATORIES

• *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.*

Want the MOST EFFICIENT TRANSMISSION LINE for Your Station?

ANDREW

WTAD-FM did. That's why they selected Andrew 6⅛" coaxial transmission line. In spite of the 800 ft. long run, including a 750 ft. run up the tower, *the overall efficiency is 90%!*

Not only is this 6⅛" line the most efficient standard RMA line used in broadcasting, but it offers the additional advantage of very high power handling capacity. It will handle up to 166,000 watts at 100 MC with unity standing wave ratio, allowing a wide margin for future power expansion.

Fabricated by Andrew in twenty foot lengths with connector flanges brazed to the ends, sections can be easily bolted together with only a couple of small wrenches. Flanges are fitted with gaskets so that a completely solderless, gas-tight installation results.

Still another advantage to buying Andrew equipment is that Andrew engineers are available to properly install it. NO OTHER TRANSMISSION LINE MANUFACTURER OFFERS YOU THIS COMPLETE INSTALLATION SERVICE!

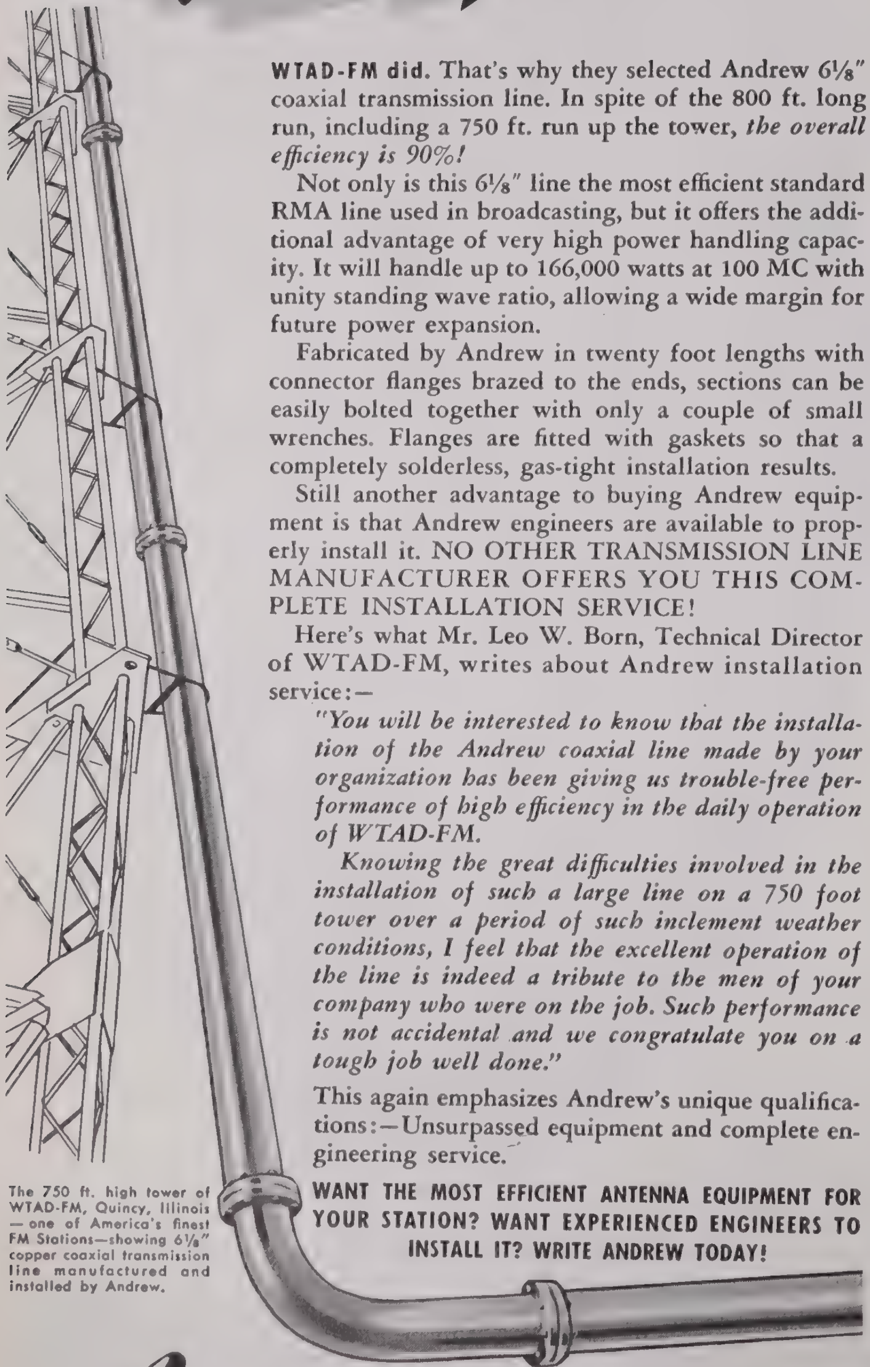
Here's what Mr. Leo W. Born, Technical Director of WTAD-FM, writes about Andrew installation service:—

"You will be interested to know that the installation of the Andrew coaxial line made by your organization has been giving us trouble-free performance of high efficiency in the daily operation of WTAD-FM.

Knowing the great difficulties involved in the installation of such a large line on a 750 foot tower over a period of such inclement weather conditions, I feel that the excellent operation of the line is indeed a tribute to the men of your company who were on the job. Such performance is not accidental and we congratulate you on a tough job well done."

This again emphasizes Andrew's unique qualifications:—Unsurpassed equipment and complete engineering service.

WANT THE MOST EFFICIENT ANTENNA EQUIPMENT FOR YOUR STATION? WANT EXPERIENCED ENGINEERS TO INSTALL IT? WRITE ANDREW TODAY!



The 750 ft. high tower of WTAD-FM, Quincy, Illinois — one of America's finest FM Stations—showing 6⅛" copper coaxial transmission line manufactured and installed by Andrew.

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TRANSMISSION LINES
ANTENNA EQUIPMENT

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STUDENT BRANCH MEETINGS

ALABAMA POLYTECHNIC INSTITUTE, IRE BRANCH

"Electronic Computers," by Mr. Sayre, Alabama Polytechnic Institute; July 5, 1948.

"Design of Class-C Amplifiers," by Professor Saunders, Alabama Polytechnic Institute; July 18, 1948.

UNIVERSITY OF IOWA, IRE-AIEE BRANCH

"The Future of Television," by five students of AIEE Branch of University of Iowa; May 5, 1948.

Motion Pictures on Atomic and Nuclear Physics; May 12, 1948.

Election of Officers; May 19, 1948.

UNIVERSITY OF TENNESSEE, IRE-AIEE BRANCH

Election of Officers; May 4, 1948.

"Fundamentals of Telemetering Systems," by C. H. Mock, University of Tennessee; July 13, 1948.

MEMBERSHIP

The following transfers and admissions were approved on August 3, 1948, to be effective as of September 1, 1948:

Transfer to Senior Member

Christensen, R. J., 1718 San Luis Rey Ave., Coronado, Calif.
Clark, E. L., 224 Lawnside Ave., Collingswood, N. J.
Davis, D. W., Carvel Hall, Annapolis, Md.
Fowler, G. A., 4119 E. Central Ave., Albuquerque, N. M.
Lurie, W. B., 821 Bronx River Rd., Bronxville, N. Y.
McCormack, R. L., Claybrook Rd., Dover, Mass.
Pontecorvo, P. J., 2 Ware St., Cambridge 38, Mass.
Reed, M. B., Electrical Engineering Department, University of Illinois, Urbana, Ill.
Rychlik, R. F., 220 Marathon Ave., Dayton 5, Ohio
Simpson, S. H., Jr., 66 Broad St., New York, N. Y.

Admission to Senior Member

Jackson, W., Electrical Engineering Department Imperial College, London S. W. 7, England
Rives, T. C., Box 412, Fairfield, Ohio
Skinner, F. J., 500 Wolfs Lane, Pelham 65, N. Y.
Warnecke, R. R., 17 Place de la Republique, Villemomble, Seine, France

Transfer to Member

Aaron, B. D., 6811 Huntington Ave., Newport News, Va.
Alsberg, D. A., Bell Telephone Laboratories, 463 West St., New York 14, N. Y.
Austin, H. B., Sandia Base Branch, Albuquerque, N. M.
Balbridge, B. H., R. R. 9, Kratzville Rd., Evansville, Ind.

Admission to Member

Clavier, P. A., 339 Walnut St., Nutley, N. J.
Durling, F. A., Box 56, Ancon, Canal Zone
Gordon, M. F., 715 N. Highland Ave., Pittsburgh, Pa.
Grace, G. M., Panamerican-Grace Airways, Lima, Peru, S. A.

(Continued on page 38A)

Introducing the *New*

DU MONT

CATHODE-RAY OSCILLOGRAPH

Type 250

FEATURING...

- ✓ a-c and d-c amplifiers
- ✓ Built-in voltage-calibrator
- ✓ Three horizontal and three vertical input choices
- ✓ Recurrent or driven sweep
- ✓ Z-axis modulation
- ✓ Provision for photography
- ✓ Brilliant traces
- ✓ Automatic beam blanking
- ✓ High-sensitivity amplifiers
- ✓ High-impedance input probe

TYPICAL APPLICATIONS REQUIRING TYPE 250...

Application No. 1: If a machine component is to be studied for its reaction under shock-load conditions, what characteristics must the oscillograph have?

Characteristics required:

1. Single sweep, variable in duration. The single sweep of the Type 250 is continuously variable from 1 second to 20 microseconds.

2. Adequate light output. The Type 5CP-A Cathode-ray Tube in the Type 250 operates at 3000 volts accelerating potential for brilliant traces.

3. High-sensitivity amplifier. Type 250 provides either d-c to 200 kc at 1 d-c volt/in. sensitivity, or 5 cps to 200 kc at .02 rms volt/in. sensitivity.

4. Automatic beam blanking, so that the fluorescent screen is excited only when signal is present on driven sweeps. This too is a feature of the new Type 250.

Application No. 2: Quantitative measurements and permanent records are to be made of the waveforms at various points in an electronic circuit.

Additional characteristics required:

1. Built-in voltage-calibrator that can be switched in before attenuator and gain control of Y-axis amplifier—a feature of the Type 250.

2. Provision for photography. Du Mont Types 271-A and 314 Oscillograph-record Cameras are designed to fit the Type 250.

3. d-c levels, a-c signals, or both, can be recorded with the new Type 250.

Other possible applications of the new Type 250 . . . Since the Type 250 was designed as a versatile general-purpose oscillograph of laboratory quality, it therefore has a wide range of applications in such fields as medicine, biology, welding, mechanics, and many other fields where a high-quality instrument for medium- and low-frequency work is required.

Why not consult us now about the possibility of applying the new Type 250 to your particular problem? Detailed specifications on request.

PRICE: $635.00 with Type 5CP1-A tube. Cat. No. 1303-E.

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DUMONT *for Oscillography*

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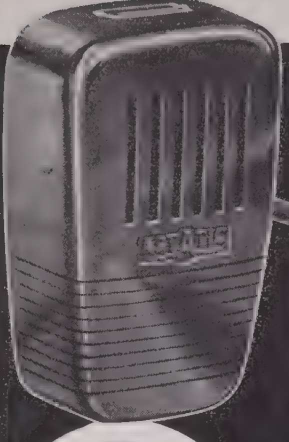
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

Usability Unlimited



the new Astatic
OS, OD and OSC MODELS
CRYSTAL,
DYNAMIC
and CERAMIC
MICROPHONES

With CB Base
For desk use. Dark brown plastic.

Lies On Its Felt Covered Back

As Hand Mike
Tapered contours allow firm, effortless grip.

Mounted on Floor Stand
Special adapter is universal fitting for conventional stands.

With Hang-up Bracket
Hangs in automobiles, etc., safely, easily accessible.

The Ideal Microphone for Many Uses—Public Address, Recording, Inter-office and Portable Communications.

IT'S A PACESETTER . . . a major new accomplishment in terms of quality performance at modest cost. And, still, that is only part of the story of this new Astatic Microphone. It has usability unlimited! It is so designed that it may be used in a variety of ways shown in illustrations. Extra convenience in all applications is offered by optional models with Type "S" off-on switch. Crystal and Ceramic models furnished in dark brown, streamlined plastic case; Dynamic models in die-cast case.

Work on AC-DC or standard circuits. Crystal and Ceramic models available with substantially flat response or rising characteristics in the voice range. Dynamic models incorporate Astatic's newly developed circular, Alnico 5 magnet, which doubles flux density, providing higher output level, extended range, and more stability, permitting highest quality performance in these more compact units. CB Base, stand adapter and hang-up bracket are accessories, and may be purchased separately.

Write for prices, additional details

SPECIFICATIONS

Model No	Type	Recommended Load Impedance	Output Level (Approx.)	Freq Response c.p.s.	Characteristics
OS	Crystal	5 Meg	—50 db	30-10,000	Substantially Flat
OS-1	Crystal	5 Meg	—50 db	30-10,000	Rising Characteristics
OD	Dynamic	500 Ohm	—62 db	30-10,000	Substantially Flat
ODH	Dynamic	5 Meg	—50 db	30-10,000	Substantially Flat
OSC	Ceramic	5 Meg	—62 db	30-10,000	Substantially Flat
OSC-1	Ceramic	5 Meg	-62 db	30-10,000	Rising Characteristics

Listed in The Radio Industry RED BOOK

Astatic Crystal Devices Manufactured under Brush Development Company patents

THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD. TORONTO, ONTARIO

MEMBERSHIP

(Continued from page 36A)

Graf, S. J., 110 N. Yale, Vermillion, S. D.
Hadsell, G. C., 349 E. Emerson Ave., Osborn, Ohio
Harms, R. G., 712 Fulton St., Farmingdale, N. Y.
Johnston, H. R., Northwestern University Technological Institute, Evanston, Ill.
Leonard, F. M., 10102 Georgia Ave., Silver Spring, Md.
Mendez, E. D., Gomez Pedraza 63, Tacubaya, Mexico, D. F.
Paulisen, H., 510 E. Sixth St., New York 9, N. Y.
Percival, W. R., 32 Kenmore Ave., Newark, N. J.
Sexton, E. M., Ohio Bell Telephone Comapny, 121 Huron St., Toledo, Ohio
Sullivan, P. E., 130 Rodney Ave., Buffalo 14, N. Y.
Swan, M. L., 3769 E. Green St., Pasadena 10, Calif.
van Gogh, W. D., Box 6943, Johannesburg, South Africa
Winn, A. L., 51 Grace, Malden 48, Mass.

The following admissions to Associate grade have been approved and will be effective as of August 2, 1948:

Alday, R. R., 1117 W. Harrison St., Chicago 7, Ill
Arnot, G. A., Jr., 401 N. Sixth St., Albuquerque, N. M.
Babintzeff, V. A., 309 Second Ave., San Francisco, Calif.
Bailey, W. R., Box 344, Bellaire, Tex.
Beattie, F. E., 4069 N. 23 St., Milwaukee 9, Wis.
Beatty, G. C., 3341 17 St., N.W., Washington 10, D. C.
Bonzon, S. V., International House 2, Oklahoma City Univ., Oklahoma City, Okla.
Burtchaell, B. M., Jr., 2039 17 Ave., San Francisco, Calif.
Clarke, H. F., Sandia Base, Albuquerque, N. M.
Cowden, E. R., 440 N. Orlando Ave., Los Angeles, Calif.
Csepely, J. A., Westinghouse Electric Corporation, Sturtevant Division, Hyde Park 36, Mass.
Dankert, E. W., Box 62-E, Fremont, Ind.
Davis, Sol, 8731 S. Wabash Ave., Chicago 19, Ill.
Dawkins, L. L., Radio Station WPTF, Raleigh, N. C.
Deb, S. S., 92 Upper Circular Rd., Calcutta 9, India
Delano, R. H., 10845 Moorpark St., North Hollywood, Calif.
Diodati, C. J., 2363 Margaret, Philadelphia 37, Pa.
Everitt, R. S., 504 S. Robles Los Ave., Pasadena 5, Calif.
Freeman, W. L., 2282 Carmelita Dr., San Carlos, Calif.
Freund, J. A., 1072 S. Broad St., Trenton, N. J.
Gabriel, R. R., 1325 S. Kolm Ave., Chicago 23, Ill.
Ginsburg, C. P., 1802 Topeka Ave., San Jose 11, Calif.
Godshall, H. K., Jr., 134 S. Second St., Quakertown, Pa.
Gratton, R. E., U. S. Weather Bureau, Wichita, Kan.
Grisanti, J. L., 817 W. Dickens Ave., Chicago 14, Ill.
Harris, G. D., 651 W. 190 St., New York 33, N. Y.
Highison, Gregory, 1101 W. Grace St., Chicago 13, Ill.
Humphries, L. W., 1202 N. Fairview, Burbank, Calif.
Javitz, A. E., 2515 Davidson Ave., New York 63, N. Y.
Jones, I. F., 608 S. Doublas, Lee's Summit, Mo.
Leger, L. P., 6510 S. Lafayette Ave., Chicago 21, Ill.
Lyon, C. M., Box 275, Wormleysburg, Pa.
Martin, R. R., 47 School St., Weston 93, Mass.
Merrill, C. W., AEO School Bldg., 102 NATTC, Memphis, Tenn.
Metcalfe, W. R., Burnt Oak, Orlestone Nr. Asford, Kent, England
Mullins, F. G., Jr., Apt. 68, Oaklee Village, Baltimore, Md.

(Continued on page 40A)

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the TELEVISION hookup wire

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Underwriters' Laboratories at **90°** CENTIGRADE — **600** VOLTS

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- Heat Resistant
- High Insulation Resistance
- High Dielectric
- Easy Stripping
- Facilitates Positive Soldering
- Also unaffected by the heat of impregnation—therefore, ideal for coil and transformer leads

Chosen after exhaustive tests by leading manufacturers of television, F-M, quality radio and all exacting electronic applications. Available for immediate delivery in all sizes, solid and stranded, in over 200 color combinations . . . ready to demonstrate anew the Efficiency and Economy of CORNISH WIRES AT WORK.

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RUBBER……75°
PLASTIC……80°
"NOFLAME-COR"……90°

"made by engineers for engineers"

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15 Park Row, New York 7, N. Y.

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Philadelphia 6

MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

GENERAL ELECTRIC
SINGLE SIDEBAND SELECTOR
SINGLE SIDEBAND 2
LOCKED OSCILLATOR
SINGLE SIDEBAND 1
NORMAL RECEPTION
OFF
ON

SINGLE SIDEBAND SELECTOR
TYPE YRS-1

SINGLE SIDEBAND SELECTIVITY *with* NO LOSS of AUDIO RESPONSE

WHEN connected to a conventional communications receiver, the General Electric Single Sideband Selector Type YRS-1 permits single sideband reception of modulated, unmodulated (CW) or single sideband transmissions. Although the system provides the effect of extreme selectivity, the audio fidelity of the selected sideband is restricted only by the fidelity characteristics of the receiver itself. Interference on either sideband can thus be minimized without impairing the quality of the signal you are trying to copy.

- Single sideband reception of modulated, unmodulated (CW) or single sideband transmissions.
- Provides the effect of extreme selectivity without restriction of audio fidelity.
- Push-button selection of either sideband—other sideband attenuated.
- Audio distortion associated with selective fading is greatly reduced.
- Intelligibility of fading signals is improved.
- Can be connected to practically any communications receiver having an intermediate frequency of approximately 455 KC.
- Normal operation is in no way disturbed when single sideband selector is not in use.

For complete information on the single sideband selector write: *General Electric Co., Electronics Park, Syracuse, N.Y.*

165-G5

GENERAL ELECTRIC

MEMBERSHIP

(Continued from page 38A)

Petraitis, L. J., 205 E. 108 St., Chicago 28, Ill.
Pierlott, R. G., Jr., 959 E. State St., Ithaca, N. Y.
Poland, W. B., Jr., 1310 27 St., N.W., Washington, D. C.
Polin, H. S., 929 Park Ave., New York 28, N Y.
Rao, L. P., 354 Thalakwadi, Belgaum, India
Rhyan, R. K., 320 N. Tenth Ave., Wauchula, Fla.
Salica, R. R., 2307 Coney Island Ave., Brooklyn 23, N. Y.
Sambor, Harry, 1640 E. 84 St., Cleveland 3, Ohio
Sarkar, Nandalal, 6 Nilmani Mitra Row, Calcutta, Cossipore, India
Sattler, E. W., Jr., 25 S. 12 St., Quakertown, Pa.
Smith, O. H., Box 123, Stringtown Rd., Evansville, Ind.
Swarup, Anand, c/o T.D.E. (I & E), Sunderwala, Camp, Dehra Dun, India
Sydnor, A. G., 407 Gartside Ct., Chester, Pa.
Voisich, Joseph, Huntington, Md.
Ward, W. E., 5015 Aldama St., Los Angeles 42, Calif.
Willcox, P. D., 515-D E. South St., Angola, Ind.
Worthington, D. T., Fransworth Radio & Television, Fort Wyane, Ind.
Young, W. S., 1140 Park Ave., Bridgeport 4, Conn.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Visual Alignment Generator for TV and FM

A new type of precision visual alignment generator, Model 7008, developed by **Philco Corp.,** Tioga & C Sts., Philadelphia 34, Pa., includes a crystal-diode high-frequency probe for use in examining the response curve of individual stages and the 4.5 Mc. video trap.

Important to the design engineer, and for demonstrations, is the use of this instrument for obtaining the correct termination of rf transmission lines, for measuring transmission-line attenuation, for measuring standing-wave ratio of transmission lines, and for determining the propagation constant of a transmission line.

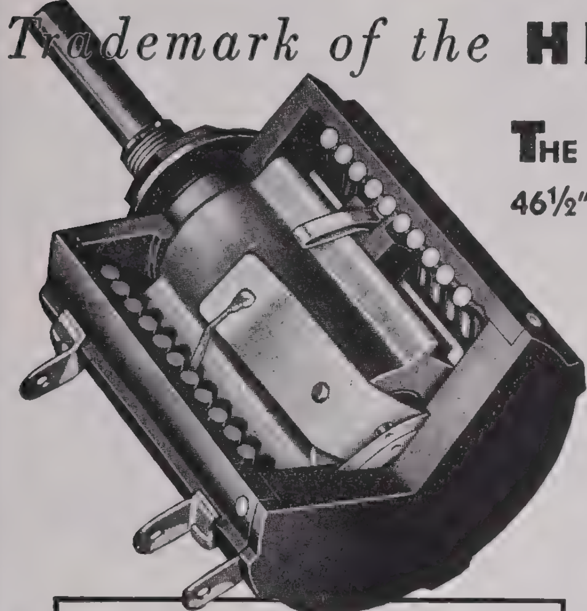
The instrument weighs only 36½ lbs. complete; it is portable, and operates entirely from the 110–120 volts, 60-cps ac line, consuming only 70 watts.

Model 7008 is a precision instrument which contains the following: a crystal calibrator, to provide accurate check points every 5 Mc. (and at other calculable frequencies); an AM (marker) generator, operating over a frequency range of 3.2–250 Mc.; an FM generator, covering a range of approximately 4–120 Mc. and 145–260 Mc with a variable sweep width of 15 Mc. maximum deviation; an audio-frequency generator, operating at 400 cps; a special oscilloscope; and a common power supply. This unique combination of circuits, with only one input and one input connection, but with individual gain controls or attenuators, provides practically complete control of all circuits, either individually or collectively. In addition to being used for the primary purpose of television or FM alignment, these circuits may be used separately when trouble-shooting.

(Continued on page 44A)

Helipot

Trademark of the **HELIcal POTentiometer!**



THE REVOLUTIONARY Potentiometer that Gives You 46½″ of Slide Wire in a Panel Space 1½″ in Diameter!

Throughout the electronic industry—wherever quality electronic instruments are designed, manufactured or used—the big news is HELIPOT, the helical potentiometer-rheostat that is making possible entirely new standards of accuracy, convenience and compactness in modern electronic equipment. Briefly, here's what makes the *Helipot* so unique . . .

Instead of a single partial turn of slide wire as found in the conventional potentiometer, the Helipot has many full turns of slide wire coiled into a compact helix requiring no more panel space than the ordinary potentiometer. The sliding contact follows the long helical path of the slide wires from end to end when a single knob is rotated. Thus, the Helipot requires the same panel space—the same single control knob—as a conventional potentiometer . . . yet it provides the wide range control and accuracy of a slide wire approximately twelve times as long.*

In other words, whereas the conventional rheostat gives approximately 300° of rotation, the 10-turn Helipot gives 3600° of rotation in the *same* panel space. Think what this important advancement can mean in simplifying the control, increasing the convenience and improving the accuracy of *your* electronic equipment. Helipots are already being used in a wide range of devices—depth sounding equipment, flight control instruments, electrical computors, strain-gage circuits, oscilloscopes and other indicating and measuring apparatus, and a great variety of other electronic applications. Let our engineering staff study *your* control problem and show you how Helipots can increase the accuracy, utility and simplicity of your equipment. There's no obligation, of course.

A SIZE FOR EVERY APPLICATION !

Helipots are available in a wide range of sizes and types to meet varying application requirements. Standard Helipots include the following . . .

Model A—Case diameter—1.8″; Number of turns—10; Slide wire length — 46½″; Rotation — 3600°; Power rating—5 watts; Resistance ratings—10 to 50,000 ohms.

Model B—Case diameter—3.3″; Number of turns—15; Slide wire length—140½″; Rotation—5400°; Power rating—10 watts; Resistance ratings—50 to 200,000 ohms.

Model C—Case diameter—1.8″; Number of turns—3; Slide wire length—13½″; Rotation—1080°; Power rating—3 watts; Resistance ratings—5 to 15,000 ohms.

In addition, special models of Helipots in production include . . .

Model D—Case diameter—3.3″; Number of turns—25; Slide wire length—234″; Rotation—9000°; Power rating—15 watts; Resistance ratings—100 to 300,000 ohms.

Model E—Case diameter—3.3″; Number of turns—40; Slide wire length—373″; Rotation—14,400°; Power rating—20 watts; Resistance ratings—150 to 500,000 ohms.

Write for data on the

DUODIAL

. . . the ideal turns-indicating dial for use with the Helipot!

Compact, simple and fool-proof, here's a dial that requires no more panel space than conventional dials. Yet it contains TWO concentric dials—a PRIMARY dial that indicates rotational position of the slider . . . and a SECONDARY dial that shows number of complete revolutions of the Primary dial. Available in a wide range of turns-ratios for all sizes of Helipots—and for other helical applications.

Send for descriptive details!

---

* For the standard 10 turn, 1½″ unit. Other sizes proportional. We are also equipped to supply other types of potentiometer-rheostats. Send us your requirements.

Send for Helipot booklet!

THE **Helipot** CORPORATION, 1011 MISSION STREET, SOUTH PASADENA 6, CALIFORNIA

NEW SHURE "900MG"

CRYSTAL
PHONOGRAPH
PICKUP
for
MICRO-GROOVE
RECORDS

Gives Maximum Reproduction of Micro-Groove Record Fidelity

The Shure "900MG" Pickup is an ideal instrument for tracking on the new micro-groove records. It tracks at 7 grams . . . has a needle force of 9 grams as added safety factor . . . uses a special offset osmium-tipped needle with a point radius of only .001″ . . . and has an output of 1 volt! The Shure lever system has been adapted in the development of this new pickup—providing a high needle compliance. Listen to it—you will be thrilled with the results!

Model "900MG" Code: RUZUZ List Price: $12.50

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SHURE

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 40A)

Twin-Trax Magnatape Recorder

Full-scale production has begun on the TWIN-TRAX Magnetape Recorder, by the **Magnephone Division, Amplifier Corp. of America,** 398-1 Broadway, New York 13, N. Y.

The Twin-Trax utilizes two separate recording tracks on standard $\frac{1}{4}''$ wide magnetic tape, and features one full hour of continuous play at the RMA standard tape speed of $7\frac{1}{2}''$ per second by recording on one track during forward travel and on the other track during reverse travel. An automatic switch and solenoid automatically reverses the direction of tape travel.

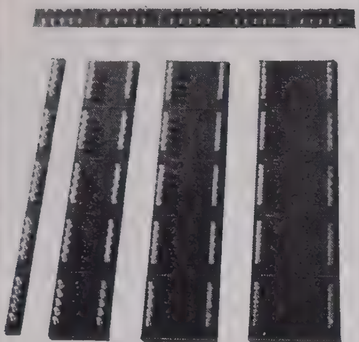
Among other special features are a frequency-response range of 50 to 9,000 cps, ±3 db, individual bass and treble equalization controls, dc on the input heaters for low hum level, and simplified tape threading which makes it virtually equivalent to placing a disk record over a turntable spindle. Twin electronic erase heads provide complete supersonic erasure of each magnetic track whenever desired. Recordings are automatically erased as a new recording is made.

The 10-tube recording and playback amplifier with built-in floating preamplifier and supersonic oscillator is contained on a single chassis, specially designed and located within the cabinet so that it can be easily slid out for servicing. Power output is 5 watts. A $6''\times 9''$ oval speaker is housed in a leatherette-covered cabinet measuring $16''$ wide $\times 14\frac{3}{4}''$ deep $\times 13''$ high.

Facilities are available for the use of a turntable and phonopickup for playing or copying 10″ or 12″ disk records onto tape. Microphone and radio-phone inputs are included. Special sockets for a VU meter and foot switch, as well as a special jack for earphone monitoring during recording and playback, are provided. In addition, by utilizing one erase head for recording, it is possible to superimpose one recording over another while listening to the original recording being played back.

(Continued on page 48A)

Save Time... Speed Assembly with CTC ALL-SET Boards!



On the assembly line and in the laboratory, CTC *ALL-SET* Boards are valuable time-savers.

With Type 158B Turret Lugs, a new board now offers mounting for miniature components. 1 1/16" wide, 3/32" thick, only. (Type X1401E.)

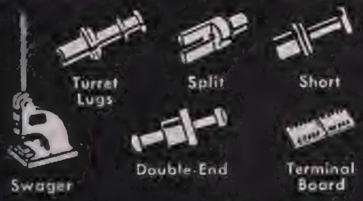
With Type 1724 Turret Lugs, boards come in four widths: ½", 2", 2½", 3" — in 3/32", ⅛", 3/16" thicknesses.

With the addition of the new miniature board, CTC *ALL-SET* Boards now cover the entire range of components.

All boards are of laminated phenolic, in five-section units, scribed for easy separation. Each section drilled for 14 lugs. Lugs solidly swaged into precise position ... whole board ready for your assembly line.

SPECIAL PROBLEMS

Custom-built boards are a specialty with CTC. We're equipped to handle many types of materials including the latest types of glass laminates ... many types of jobs requiring special tools ... and all types of work to government specifications. Why not drop us a line about *your* problem? No obligation, of course.



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The Guaranteed
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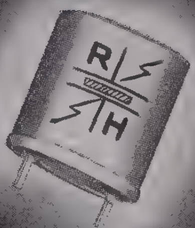
Specify



RH-7 CRYSTAL UNITS

Widely used for all forms of mobile communications equipment, RH-7 plated crystals offer a standardization on one holder, with an option of pins or wire leads, to cover every frequency range.

Small, compact, and hermetically sealed, the gold vapor plated RH-7 is built to withstand rough treatment in every mobile radio application.

Standardize now with RH-7.

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News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 44A)

Flying-Spot Cathode-Ray Tube

The **Tube Department, Radio Corporation of America,** Harrison, N. J. has produced a "Flying-Spot" cathode-ray tube, RCA-5WP15, which enables television stations to employ a flying-spot video-signal generator which permits the telecasting of individual station call letters and test patterns from interchangeable slide transparencies or from opaque surfaces.

This new "Flying-Spot" tube furnishes a small, rapidly moving spot of radiant energy (hence the name "flying spot") for scanning a slide transparency or opaque object. It thus makes possible a relatively simple and inexpensive video-signal generator capable of producing not only a repetitive picture signal like the monoscope, but also of permitting change of picture at will and of reproducing the picture with the halftone fidelity of photographic film.

Featured in the 5WP15 is a new extremely short-persistence phosphor having a large component of its energy emission in the near-ultraviolet region. The persistence of the ultra-violet radiation is so extremely short that the amount of equalization needed in the video amplifier to minimize trailing in the reproduced picture is small and can be supplied by a single network. As a result, circuits and adjustments are relatively simple.

The video-signal generator made possible by the 5WP15 consists essentially of (1) the flying-spot tube with associated power supplies, deflection yoke, and scanning circuits to provide a small, rapidly moving source of radiant energy; (2) a lens of the enlarger type to project the raster on the subject to be scanned; (3) the subject which may be a slide transparency, motion-picture film, or an opaque object; (4) a multiplier phototube, such as the RCA-931-A, with associated power supply to intercept the radiation transmitted or reflected by the subject, and convert it into video signals; and (5) an amplifier to increase the strength of the video signals.

(Continued on page 56A)

NEW 15/16" CONTROLS

ACTUAL SIZE!

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In Canada: CANADIAN MARCONI CO., Ltd.
Montreal, P.Q., and branches

Positions Wanted

(Continued from page 54A)

RADIO ENGINEER

English radio engineer seeks position in communications. Fully qualified by examination. 12 years experience. Leslie F. Bennett, c/o Mercantile Trust Bank, Baltimore, Md.

JUNIOR ENGINEER

Electrical Engineer graduate. Age 24. Single. B.S.E.E., February 1948. Some experience in television field. Seeks interesting position with good company in New York City area. Box 190W.

ELECTRONIC ENGINEER

Recent New York University graduate B.S.E.E. Age 27. Single. Excellent experience in electronics. Desires position in electronic circuit design and development in New York metropolitan area. Résumé on request. Box 191W.

TELEVISION ENGINEER

Graduating American Television Institute of Technology, November 1948 with B.S.T.E. Age 26. Married. 1st class F.C.C. license. 4 years maintenance Navy radio equipment. Trained in Operation and Maintenance of R.C.A. Image Orthicon and DuMont equipment. Desires position in television broadcasting field. Box 192W.

JUNIOR ENGINEER

Three years electrical engineering college, major in electronics, continuing studies for B.S. in E.E. at night. Desires work as Junior Engineer in design and development of communication equipment under Senior Engineer. Prefer Long Island. Box 193W.

ENGINEER

Graduating University of Michigan, August 1948 with B.S.E.E. in communications. Age 24. Married. Two years Army radar (G.C.A.). Two years shop experience. Interested in sales or development engineering. Prefer midwest area. Box 194W.

JUNIOR ENGINEER

Graduate R.C.A. Institutes. Age 27. Married, 1 child. Desires work West coast in television, radio, electronics research or development. Limited Air Force experience. Ambitious, persevering. Box 195W.

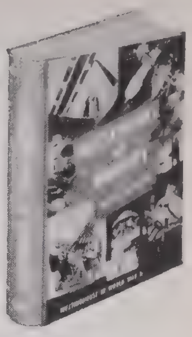
ELECTRONICS ENGINEER

Present head, Technical Department, educational organization wants change. College Electronics Dept., Chief Engineer of station or consulting research. College graduate, 10 years radio experience and all FCC radio licenses. Age 31. Married. $6,000 salary. Box 196W.

RADIO ENGINEER

Radio Engineer, currently employed in commercial engineering division of metropolitan tube manufacturer, desires change to permanent position in midwest. Age 27, married, 1 child. B.S. in physics, graduate Army Electronics Training Center, M.I.T., Harvard, 3 years military experience, special roving radar officer US and ETO, 2 years commercial circuit work in present position. Minimum salary $5,500. Box 184W.

A stirring account of industry's war-time role



BATTLEFRONTS OF INDUSTRY

By DAVID O. WOODBURY

Well-known author of books and articles on science.

This is the dramatic story of Westinghouse Electric's contribution to the war effort—a story in many ways typical of American industry as a whole. Since very little has been told about industry's part in winning the war, this history of its "battlefronts" is doubly interesting. The author stresses the ingenuity of scientists and engineers in meeting and overcoming technical problems. He explains how the application of mass production techniques made possible the speedy completion of assignments considered impossible in peacetime. *Battlefronts of Industry* also emphasizes the important role of scientific research and its contributions to victory.

Contents include:

A Challenge for Genius; As a Good Citizen; Toward a Shooting War; Ordnance in a Big Way; High Pressure in Steam; To Shoot Straight; War Story of a Factory; Hitting on all Twelve; Research; Research Helps War Industry; X-Rays and War; Lights to Fight; Ordnance Round-up; Vital Measurements; "The Impossible Takes a Little Longer"; The Turbine Forges Ahead; Uranium; Battle of the Isotopes; An End and a Beginning.

June 1948 342 pages $3.50

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Please send me, on 10 days' approval, a a copy of Woodbury's BATTLEFRONTS OF INDUSTRY. If I decide to keep the book, I will remit $3.50 plus postage; otherwise, I will return the book postpaid.

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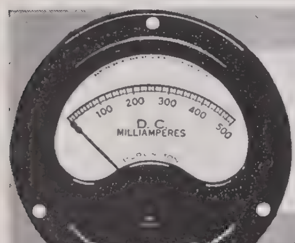
Balance Weights



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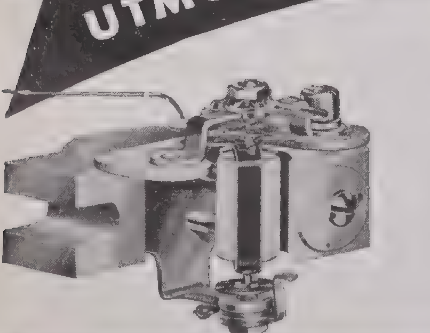

BALANCE WEIGHTS of helical type phosphor bronze, formed in a manner which eliminates slipping or shifting, are used to balance the moving element. All ranges AC and DC available in 2½", 3½", 4½" rectangular or round case styles and are guaranteed for one year against defects in workmanship or materials. Refer inquiries to Dept. I 98.

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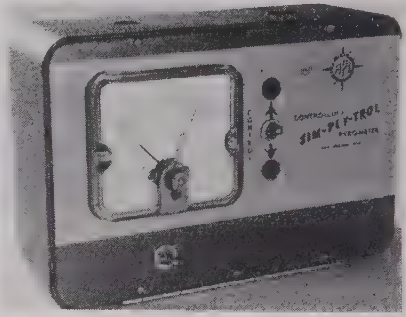
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Pyrometer with Lock Contact

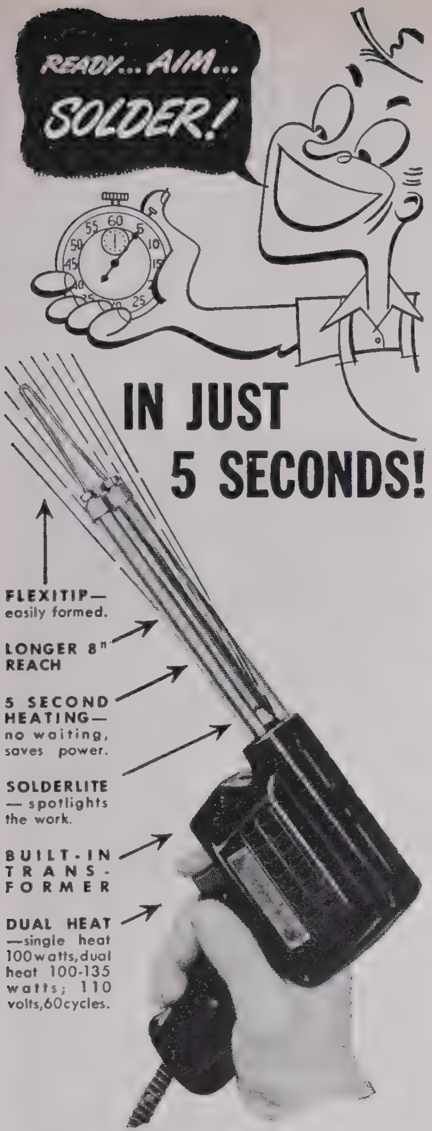
The Simplytrol Indicating and Controlling Pyrometer is a thermocouple-type control for furnaces, ovens, kilns, etc. It operates on the Micro-Contact principle recently developed by **Assembly Products Inc.**, Main & Bell Sts., Chagrin Falls, Ohio.



The high-resistance millivoltmeter-type indicator is equipped with platinum contacts that close when the set temperature is reached. Positive contact is assured by the Micro-Contact arrangement, which operates at the instant of initial contact. This locks the contacts together with sufficient pressure to prevent chattering or floating. The contacts are spring loaded and remain locked together until it is time for them to release; at which time they are forcefully separated with sufficient pressure to eliminate any possibility of sticking. In actual operation, the Micro-Contact circuit is interrupted every few seconds but closes again immediately if the temperature is still up to the control point. However, if the temperature has dropped below the control point the contacts remain open and time-delay load-control switch closes.

The Simplytrol is an extremely low differential controller. The difference between shut-off and turn-on millivolts is nearly zero. Straight-line control can usually be obtained if desired. The load-control switch is conservatively rated at 10 amperes, 125 volts. Indicators calibrated in both Fahrenheit and Centrigrade are available in these standard ranges: 0–2500°F and 1370°C; 0–1500°F and 800°C, 0–500°F and 260°C. The Simplytrol operates from regular 110 or 220 volts ac or 110 volts dc. When used on dc supply, the thermocouple must be insulated from ground. For ac supply installations, an isolating transformer is included and the thermocouple may be operated grounded if desired.

(Continued on page 57A)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IN JUST 5 SECONDS!
FLEXITIP— easily formed.
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SOLDERLITE — spotlights the work.
BUILT-IN TRANSFORMER
DUAL HEAT —single heat 100 watts, dual heat 100-135 watts; 110 volts, 60 cycles.

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Other advantages? Just check the features of the Weller Gun illustrated. See why it's called the "handful of soldering convenience".

Solderlite, extra length, and the easily shaped Flexitip means real soldering ease. And because the transformer is *built in*—not separate—the Weller Gun is a complete, self-contained unit, compact, convenient, safe.

For laboratory and maintenance work, we recommend the efficient 8" model—DX-8 with dual heat; or 4" types S-107 single heat and D-207 dual heat. Order from your distributor or write for bulletin direct.

WELLER MANUFACTURING COMPANY

821 Packer Street • Easton, Pa.

News—New Products

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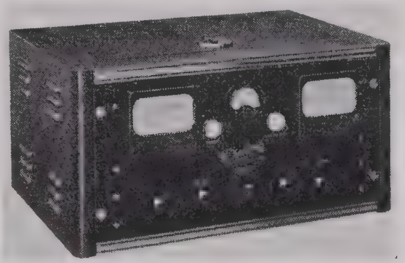
(Continued from page 56A)

Frequency and Modulation Monitor

A new frequency and modulation monitor for the FM emergency services which is claimed to provide features not heretofore available in one instrument has been announced by **Doolittle Radio, Inc.,** 7421 S. Loomis Blvd., Chicago 36, Illinois.



Classified as the FD-12, this monitor handles, one, two, three, or four frequencies anywhere between 25 Mc to 170 Mc, checks frequency deviation and percentage of modulation with accuracy to ×0.0015%. For example, the operator can use two frequencies in the 30–50-Mc band, one frequency in the 72–76-Mc band, and one frequency in the 152–162-Mc band, or any combination of frequencies up to four, on the same or different bands.

When the equipment is provided for operation on frequencies occurring in different bands, the unit is provided with plug-in type antenna coils for those frequencies which are in different bands. No adjustments are necessary when changing bands other than to change the position of the selector switch and change the antenna coil.

The unit employs crystals which are thermally controlled for those frequencies above 50 Mc. The accuracy is guaranteed by the manufacturer to be ×0.0015% over the range of 15°C to 50°C.

If and discriminator are calibrated and centered by means of a local oscillator. This oscillator may be directly compared with WWV with the aid of a communication receiver. The unit has self contained means for setting if and discriminator.

Direct reading of modulation up to 20 kc on positive or negative peaks and the peak flasher to show overmodulation can be set at any value from 5 to 20 kc for either positive or negative peaks.

The sensitivity for measuring is 500 microvolts or less across the antenna terminals. The circuit is so designed that it is possible to measure distortion in a transmitter.

The entire equipment is mounted on a black anodized panel measuring 3¾″×19″, and is 14″ deep. It can be rack-mounted or provided with a cabinet.

A 500-ohm output is provided for audio monitoring. Power consumption is 80 watts. The unit operates on 110 volts, 60 cps, ac, and meets all FCC requirements. Shipping weight is 60 lbs.

(Continued on page 58A)

The theory and application of electronics in industry

Industrial Electronics Reference Book

By Electronics Engineers of the Westinghouse Electric Corp.

This book was compiled to answer the need for complete and clear information on the application and design of industrial electronic equipment. Written by a group of engineers, each an expert in his particular branch of electronics, the *Industrial Electronics Reference Book* contains the most recent information on the subject. The material is directed at the practicing engineer. Its aim is to give him a better understanding of the scope and limitations of electronic apparatus as it is applied to industrial processes.

Contents Include:

Physical Background of Industrial Electronics; Electron Emission; Control of Free Electrons; Electrical Conduction in Gases; Vacuum Tubes; Gas Tubes; Photoelectric Devices; Industrial X-Ray Tubes; Cathode-Ray Tubes; Ultraviolet Radiators; Circuit Elements; Tuned Circuits and Filters; Transformers; Vacuum Tubes as Circuit Elements; Electronic Motor Control; Industrial Photoelectric Control; Care and Maintenance of Electronic Apparatus.

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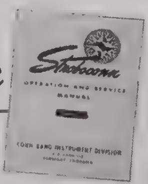

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News—New Products

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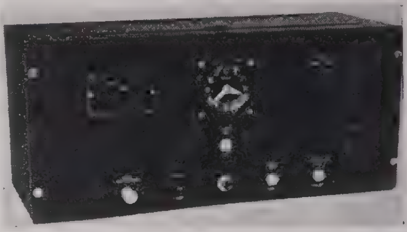
(Continued from page 57A)

Frequency Standard

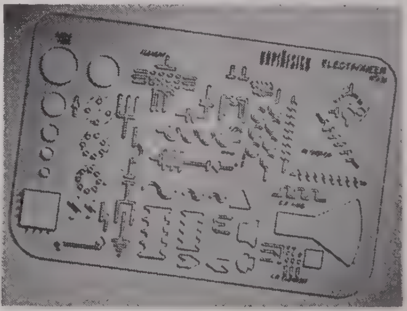
Designated as Type 2121A (licensed under U.S. patents of Western Electric Co.), a frequency standard is being manufactured by **American Time Products, Inc.,** 580 Fifth Avenue, New York 19, N. Y.



Type 2121A provides an accuracy of one part in 100,000. Temperature coefficient is less than 1 part per million per °C. The tuning fork is hermetically sealed. Outputs are: 60 cps, 0–110 volts at 0 to 10 watts (variable); 120 cps pulses, 30 volts negative, 240 cps pulses, 30 watts positive and negative. A clock is provided for comparing with time signals. Multivibrators are not used. Power input is 110 volts, 50 to 400 cps at 45 watts, standard $8\frac{3}{4}''$ panel. Net weight is 25 lbs. with cabinet.

New Design and Drafting Template

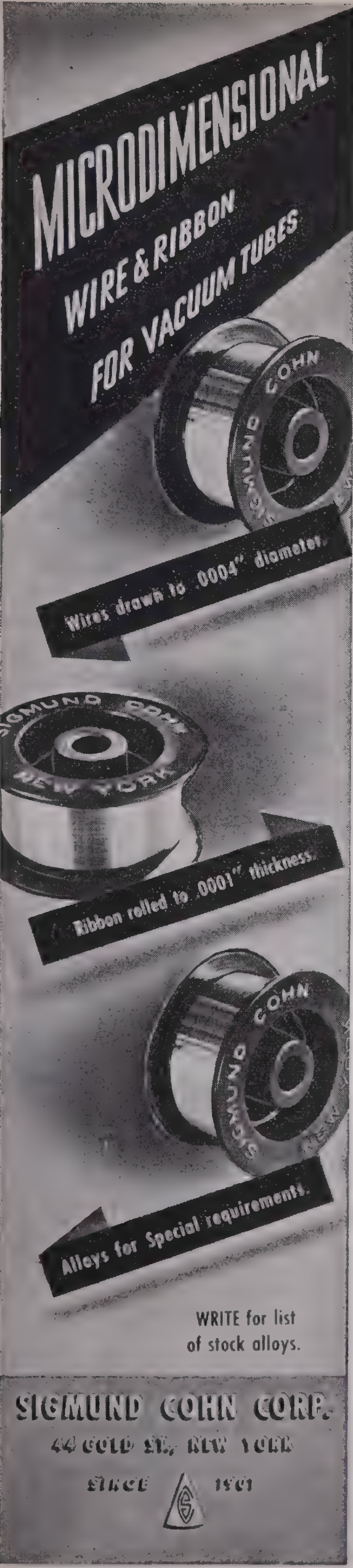
The No. 31 Electroneer Template for use by all design and drafting personnel in the industrial electronic, television, radio, and electrical engineering fields is now available from **Rapidesign, Inc.,** P.O. Box 592, Glendale, Calif.



The No. 31 Electroneer cut-outs cover all the commonly used symbols. The smooth, clean beveled edges permit the quick and easy delineation of layout and schematic drawings.

The Electroneer is made of clear, mathematical-quality cellulose nitrate sheet of 0.040″ thickness, with printing on the reverse side to prevent wearing off. Actual size is $4\frac{1}{4}'' \times 6\frac{1}{2}''$.

(Continued on page 59A)



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News—New Products

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(Continued from page 58A)

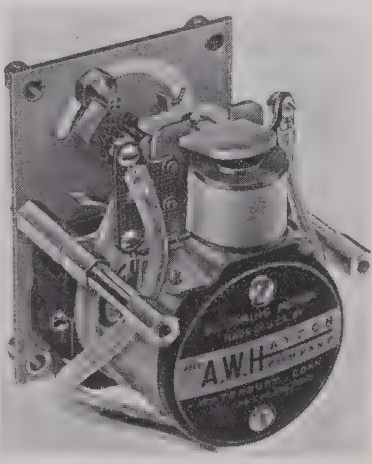
Correction Notice

"Multivue Cap Pilot Light Effective With Neon Lamp," manufactured by **Dial Light Co. of America, Inc.,** 900 Broadway, New York 3, N.Y., incorporates a new principle of refracted light from glowing electrodes to obtain new effectiveness for the NE-51 neon glow lamp.

Incorrectly identified in our August issue, this lamp has a built in resistor for 110 or 220 volts. A small additional resistor is required for higher voltages.

AC and DC Time Delay Relays

The new series 11400 ac and 6400 dc Time Delay Relays are available from **A. W. Haydon Company,** 111 W. Main St., Waterbury, Conn.



These relays have an ingenious planetary differential and "capstan" type clutch mechanism which is designed to drive the switch actuating arm when the clutch holds the third element of the differential stationary. Mechanical amplification of forces obtained in the "capstan" clutch allows the use of a small electromagnet, thus reducing the operation current and size of the unit considerably. The "capstan" clutch also resists vibration and shock and assures positive operation under adverse conditions.

Almost any time-delay interval is made possible through the use of time proven ac and dc timing motors with a wide choice of voltage and speed ratings. Exceedingly compact and with a weight of approximately 1 lb., their flexibility of design permits modification to specifications for individual applications.

(Continued on page 60A)

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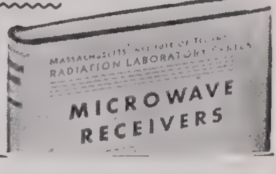
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MICROWAVE RECEIVERS

Technique of Microwave Measurements

Vol. 11. Edited by C. G. MONTGOMERY, Associate Professor of Physics, Yale University. 937 pages, illustrated, $10.00

This book describes in detail the procedures for measuring the properties of microwaves and the circuits in which they are used. A full description of the measurable quantities of microwaves provides sound groundwork for subsequent material dealing with sources of power suitable for measuring purposes and the means for detecting energy at microwave frequencies. Methods for measuring wave lengths, impedance, frequency and attenuation are fully described.

Microwave Receivers

Vol. 23. Edited by S. N. VAN VOORHIS, Associate Professor of Physics, University of Rochester. 611 pages, illustrated, $8.00

An authoritative analysis of all the elements making up a wide-band receiver. It describes individual circuit types—describes the assembly, testing and maintenance of microwave receivers—offers actual receivers as examples of practical circuit combinations.

Theory of Servomechanisms

Vol. 25. Edited by H. M. JAMES, Purdue University, N. B. NICHOL, Taylor Instrument Co., and R. S. PHILLIPS, University of Southern California. 375 pages, illustrated, $5.00

Here is a coherent description of the theory and mathematics involved in the standard techniques of servomechanism design, presenting new views and data. It covers frequency response design considerations—transfer loci, attenuation vs. log-frequency plots, and phase-angle vs. log-frequency plots—and explains a new method which produces desired results in the presence of electrical noise and other disturbances.

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☐ Van Voorhis—Microwave Receivers	$8.00
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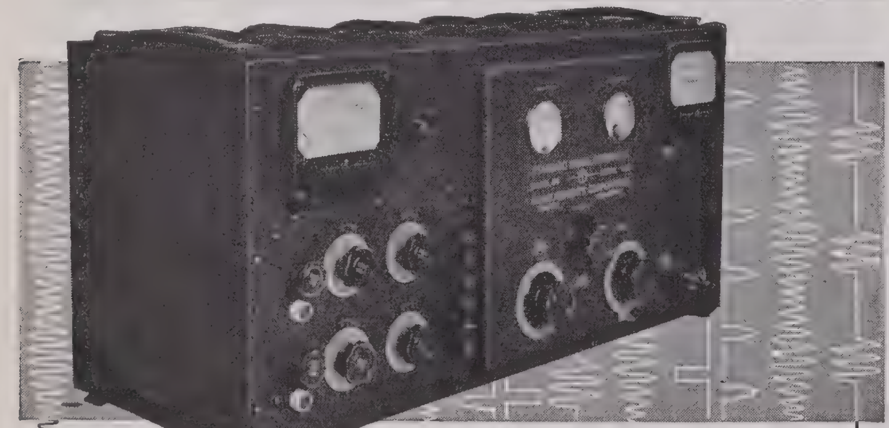


U.H.F. STANDARD SIGNAL GENERATOR *MODEL 84*

SPECIFICATIONS

CARRIER FREQUENCY: 300 to 1000 megacycles.

OUTPUT VOLTAGE: 0.1 to 100,000 microvolts.

OUTPUT IMPEDANCE: 50 ohms.

MODULATION: SINEWAVE: 0—30%, 400, 1000 or 2500 cycles. PULSE: Repetition—60 to 100,000 cycles. Width—1 to 50 microseconds. Delay—0 to 50 microseconds. Sync. input—amplifier and control. Sync. output—either polarity.

DIMENSIONS: Width 26", Height 12", Depth 10".

WEIGHT: 125 pounds including external line voltage regulator.

Laboratory Standards

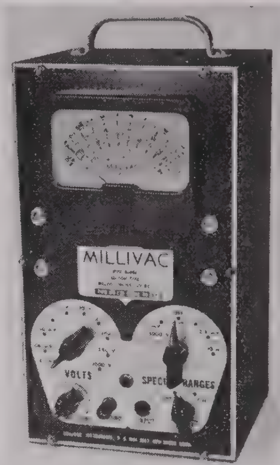
MEASUREMENTS CORPORATION
BOONTON · NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

DC Millivolt Meter



Millivac Instruments, P.O. Box 3027, New Haven, Connecticut, have designed the new Model MV-17A meter which measures one millivolt (1 mv) full scale on its lowest range at 6 megohms input impedance (6000 megohms per volt). With 150 micromicroamperes (150 trillionths of an ampere) it will give a full scale deflection. This permits resistances of 10^{13} to 10^{14} ohms to be measured with an external voltage source. If used with a sensitive rf thermocouple, the meter will measure better than 10 db below 1 mw. This ultrasensitive dc millivolt meter can also be used for galvanometer work, where it can be overloaded 100,000 times on its lowest voltage range. It is equipped with 12 additional ranges to read up to 1000 volts at 60 megohms input impedance.

Model MV-17A contains a high-impedance shunting contact-type magnetic modulator. It converts dc input voltages into a 120 cps carrier wave, which is amplified, rectified, and metered. The meter is completely stable due to the absence of bridge circuits and because it has its own built-in voltage regulator. No zero adjustment whatever is used on all ranges of 10 mv full scale and above.

New Enterprises

A new laboratory, engaged in microwave and electronic development, has been established by Russell and Sigurd Varian at 98 Washington St., San Carlos, Calif.

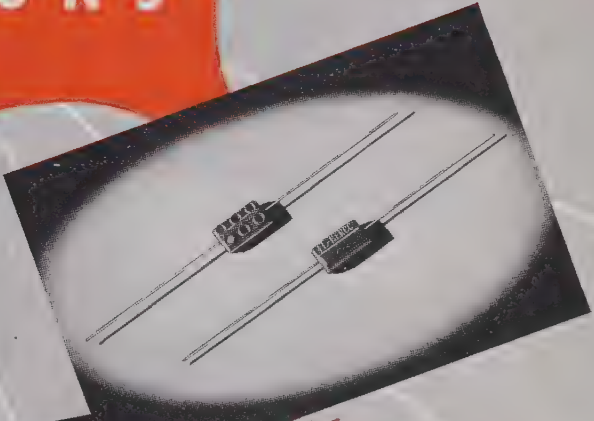
This organization, to be known as **Varian Associates,** is comprised of a number of scientists, who were previosuly associated with Dr. R. Varian in the development of the klystron tube and other microwave devices and test equipment.

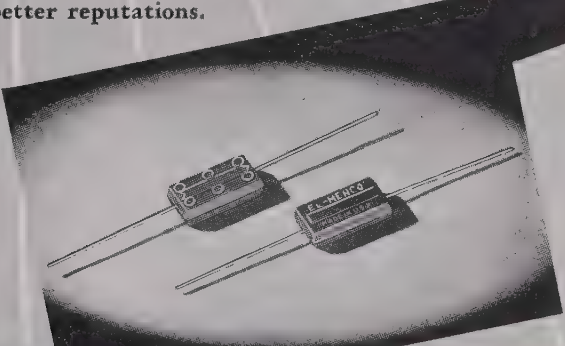
Among the consultants and staff members of this organization are: H. Myrl Stearns, vice-president and general manager, Elliot Levinthal, Fred L. Salisbury, Don L. Snow, Leonard I. Schiff, Wm. W. Hansen, and E. L. Ginzton.

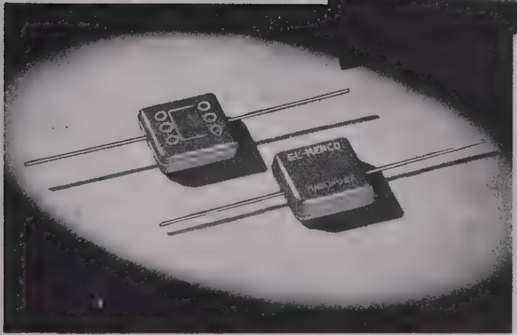
better components build better REPUTATIONS

...specify El-Menco

No product is better than its weakest component. This is why more and more manufacturers now use EL-MENCO mica capacitors. Rather than risk their reputations on inferior components they automatically specify El-Menco — the mica capacitor with the kind of performance that always gives customer satisfaction and builds better reputations.







New

CM 15 MINIATURE CAPACITOR

9/32" x 1/2" x 3/16"

For Radio, Television and Other Electronic Applications

2 to 420 mmf. capacity at 500 v DCA

2 to 525 mmf. capacity at 300 v DCA

Temp. Co-efficient ± 50 parts per million per degree C for most capacity values

6-dot standard color coded

CM 20 CAPACITOR

Available in "A", "B", "C" and "D" characteristics

2 to 1500 mmf. in tolerances down to ± 1%* or .5 mmf. at 500 D.C. working voltage

6-dot color coded

*Whichever is greater

CM 35 CAPACITOR

Available in "A", "B", "C", "D" and "E" characteristics

Minimum tolerance 1%

500 D.C. working voltage

6-dot color coded

ARCO ELECTRONICS
135 Liberty St., New York, N. Y.
Sole Agent for Jobbers and
Distributors in U. S. and Canada

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT

Foreign Radio and Electronic Manufacturers communicate direct with our Export Dept. at Willimantic, Conn. for information

MICA CAPACITORS
by
THE ELECTRO MOTIVE MANUFACTURING CO
WILLIMANTIC CONNECTICUT

Write on your firm letterhead for Catalog and Samples

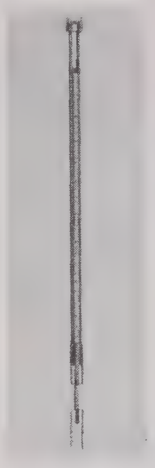
MOLDED MICA El-Menco MICA TRIMMER
CAPACITORS

NEWS and NEW PRODUCTS

October, 1948

"Slipstick" Wavemeter

A new tool for engineers and experimenters is the DM 103W "Slipstick" Wavemeter by **Decimeter, Inc.,** 1428 Market St., Denver, Colo.

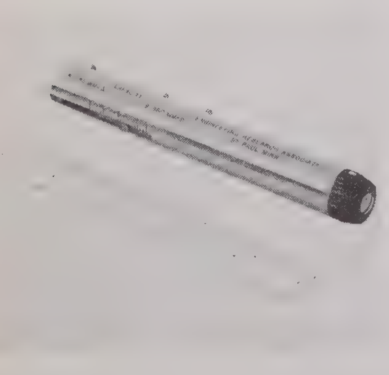


It gives quick and accurate frequency readings on oscillators, receivers, or transmitters in the uhf spectrum. The Slipstick is coupled to the oscillator by inserting the square plastic tip into the rf field. Frequency is measured by the simple expedient of sliding the center rod out until a sharp reaction appears in the grid current, plate current, or output to a radio-frequency detector. When reaction is obtained, the frequency of the oscillator may be read directly on the sliding scale.

In measuring received signals, the Slipstick is coupled to the antenna circuit. A sharp fluctuation of receiver output occurs when the Slipstick is tuned to the incoming signal. Accuracy is 2% or better; range is 90 to 3000 Mc. Sliding and stationary rods have a highly polished silver finish. Handle, guide, and tip assemblies are of amber polystyrene to insure low loss and permanence. For further information, write for Circular 11D.

Miniature Variable Capacitor

A new miniature variable capacitor for applications where space is restricted and durability is required has been announced by **Engineering Research Associates, Inc.,** 1902 West Minnehaha Ave., St. Paul, Minn.



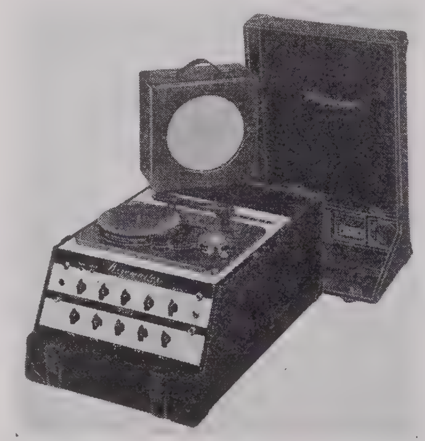
This capacitor has rated capacitance of 9 to 585 $\mu\mu$f per section, with less than 0.002% dissipation factor at radio frequencies.

It has a self-contained dial with micrometer action; may be temperature compensated; and is made up in many designs, ganged or single section.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Wide-frequency-Response Portable Wire Recorder

This combination unit is claimed by the manufacturer to produce fidelity which surpasses that of acetate-disk recording. It features a built-in radio and phonograph and plays through a Jensen 8″ PM speaker, housed in a separate cabinet to avoid vibration and acoustical feedback. Designated as the WIREMASTER, it is being produced by **Precision Audio Products, Inc.,** 1133 Broadway, New York 10, N. Y.



The Wiremaster uses 13 tubes, and records and reproduces a frequency response of 40–10,000 cps, Noise level is–70 db and it records at 2′ per second.

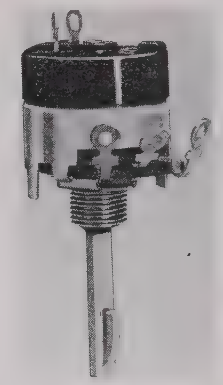
A speaker monitoring control enables the user to adjust the listening volume to his own–liking when recording, without affecting the recording volume, which is regulated by another control.

The Wiremaster has an automatic braking device which stops both spools from turning when the current is suddenly cut off, preventing the wire from unraveling and tangling. Spools also automatically shut off when either one is completely unwound. The recorder rewinds at an 8:1 ratio.

The unit has 2 microphone channels, is housed in a 2 tone leatherette portable case, which measures 23″×15″×12″. It weighs 49 lbs complete. The power supply is 105 to 120 volts, ac, 60 cps.

New Type Variable Resistor

A new 15/16″ variable resistor, the Mallory Midgetrol, described as being the first basically new design in this field for many years, has been announced by **P. R. Mallory & Co., Inc.** of Indianapolis, Indiana.



In addition to the space-saving feature common to 15/16″ controls, the "Midgetrol" has electrical characteristics which make it suitable for many applications previously requiring a $1\frac{1}{8}''$ control.

The new design and production methods are said to produce an extremely low mechanical and electrical noise level. Moreover, tests run both by Mallory and its customers demonstrate that the unusually quiet operation is maintained after tens of thousands of cycles of operation.

One new feature is a flat shaft which is easily adapted to fit any type of knob now in use. Other design features include two-point shaft suspension, providing even contact pressure at all points of rotation; machine-coated carbon elements which produce accurate resistance values and smooth tapers; hot-tinned terminals; fully insulated current-carrying parts, and a special phenolic shaft for television applications.

A complete descriptive folder and specification sheet are available on request.

Unicon Plastic Capacitors

A recent product of **United Condenser Corp.,** 422 East 138 St., New York 54, N. Y., is a line of plastic capacitors.

The manufacturer states that the dielectric hysteresis of plastic capacitors is one tenth that of similar mica insulated units. In actual laboratory tests, a 1-μf. capacitor had a residual charge of 0.08% of an original 3000-volt charge after being discharged through a short circuit for 0.1 second. Hermetically or wax-sealed assemblies are available in single or multiple units with ratings as high as 5 μf at 25 kv. Leakage resistance is 400 kilomegohms per μf, power factor is 0.05%, and continuous operation is satisfactory at temperatures up to 65°C.

(Continued on page 24A)

Lavoie

UHF PRECISION INSTRUMENTS

Lavoie

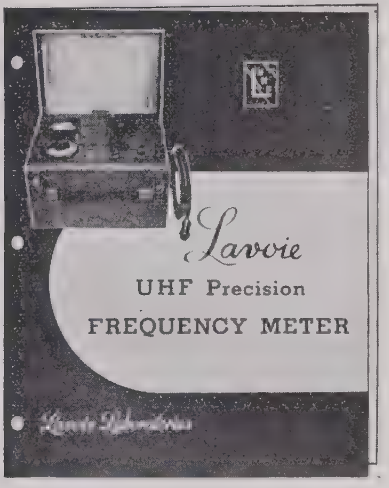
HARMONIC FREQUENCY GENERATOR

Lavoie Laboratories

PROVIDES harmonic output voltages in 10 or 40 mc series with crystal-controlled accuracy.

SELECTS 10 or 40 megacycles series by means of front panel switch.

USED FOR calibration of receivers, wavemeters, or (with Beat Detector built into instrument) for calibration of oscillators and signal generators. May also be used in conjunction with a low-frequency communications-type receiver to determine UHF oscillator drift. A mixer unit is available for this application.



Lavoie

UHF Precision

FREQUENCY METER

Lavoie Laboratories

Completely portable Accuracy 0.1% Models available from 100 to 2000 megacycles with 2 to 1 frequency coverage on each model.

RECOMMENDED FOR:

- Production testing
- Measurement of oscillator drift
- Independent alignment of transmitters and receivers
- Precise measurements of frequencies

FULL DETAILS ON REQUEST

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

Bliley
CRYSTALS

MILITARY
COMMERCIAL
BLILEY

with type BH6 Bliley engineering has anticipated your VHF requirements...

Type BH6 is available up to 100 MC and can be furnished to meet all standard specifications, military or commercial. This means your design considerations can be simplified by elimination of unnecessary multiplier stages. Write for information covering latest recommended oscillator circuits and associated crystal data.

Bliley
CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BLDG. • ERIE, PA.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 22A)

Stabilized Heat Crystal Holder

Designed to accommodate crystals from 80 to 10,000 kc, and recommended for broadcast and frequency-standard applications, the JKO-7, manufactured by the **James Knights Co.,** Sandwich, Ill., is now being marketed.

JK
STABILIZED HEAT
THE JAMES KNIGHTS CO.
SANDWICH, ILL. U.S.A.

It has a large 7-pin base and will accommodate most JK holders besides accommodating more than one small holder. The input is 6.3 volts, and the operating temperature is 50°C. ±1°. This unit is available as a double oven or built to specifications on special order. The crystals are electrostatically shielded. Better thermal insulation results in lower heater-current consumption and shorter warm-up time. This component may be mounted in any position.

Pocket-Size Battery Tester

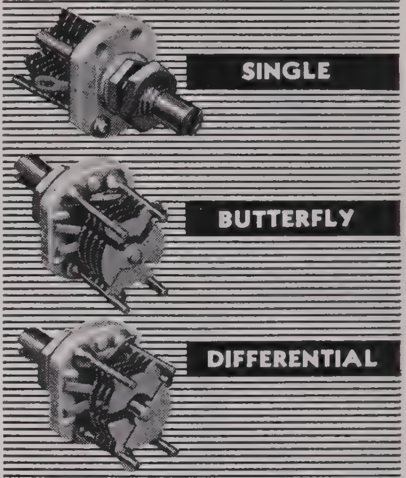
A new pocket-size battery tester is now being marketed by the **Simpson Electric Co.,** 5216 W. Kinzie St., Chicago 44, Ill.

Designed in accordance with the engineering specifications of leading battery manufacturers, its loading resistors have an accuracy of 1% and properly load all radio and hearing-aid "A" and "B" batteries. Operation of the tester is simple. A single rotary switch selects the voltage of the battery under test and brings into line the correct loading resistor. A percentage scale shows the exact condition of the battery in percentage of full voltage. Needlepoint prods with which the tester is furnished assure positive contact regardless of the type of terminal on the battery.

Three arcs are shown on the full 3″ dial. One arc is for all radio "A" batteries, one for hearing-aid "B" batteries, and one for all "B" batteries, whether radio or hearing aid. Each arc is divided and marked in three sections, "good," "weak," and "bad." Limits for these markings are set in accordance with specifications of battery manufacturers.

(Continued on page 42A)

JOHNSON
a famous name in Radio



SMALLEST
AIR VARIABLES
EVER PRODUCED

Pictured are three of the smallest air variables ever produced. Each of the three types is available in four different capacities.

SINGLE TYPE—Takes the place of adjustable padders for trimming RF and IF oscillator circuits. Available in four models: 1.55 to 5.14 mmf, 1.73 to 8.69 mmf, 2.15 to 14.58 mmf and 2.6 to 19.7 mmf.

BUTTERFLY TYPE—Applicable wherever a small split stator tuning condenser is required. Available in four models: 1.72 to 3.30 mmf, 2.10 to 5.27 mmf, 2.72 to 8.50 mmf, and 3.20 to 11.02 mmf.

DIFFERENTIAL TYPE—For switching capacity from rotor to either of two stators, and for shifting tap on capacity divider. Available in four models: 1.84 to 5.58 mmf, 1.98 to 9.30 mmf, 2.32 to 14.82 mmf, and 2.67 to 19.30 mmf.

For Full Details Write For Latest JOHNSON Catalog

E. F. JOHNSON CO.
WASECA, MINNESOTA

See How Springs Stay Springy

...despite high HEAT and active CORROSION when made of INCO NICKEL ALLOYS

G. E. *Automatic Toaster uses five Inco Nickel Alloy springs to insure long-time operation. Temperatures up to 500° F.*

Yale & Towne *"Tip Toe" Automatic Iron uses Inconel coil spring for the flexing arm of the sole plate. Corrosive steam here from damp clothes.*

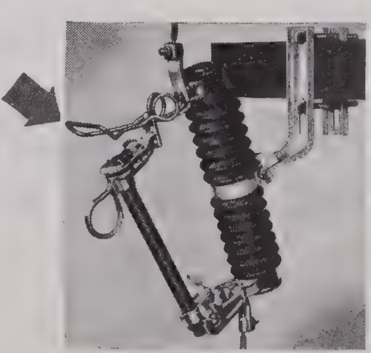
Westinghouse *Sun Lamp uses "Z" Nickel springs to support quartz tube inside the lamp. Temperatures up to 750°.*

Look at these well-known appliances, and consider the user-benefits they offer the consumer

How to provide for long-time strength and resiliency at elevated temperatures, particularly in the presence of corrosives, poses a problem. The springs in the appliances shown above withstand temperatures ranging from 500° to 750° F. Two operate in the presence of moisture. The springs in the fuse cutout switch shown here maintain their excellent spring properties even when subjected to salt and sulphurous atmospheres in heavy industrial areas.

Inco Nickel Alloy springs are particularly useful in applications where corrosion or high temperatures are present. Their fatigue-resistant properties are often of prime value, but most apparent where corrosion and heat are factors.

For example, consider the G. E. Automatic Toaster: The pop-up spring has to retain spring properties after long exposure to temperatures up to 500° F. This and three similar springs subject to 400° F. are all made of Monel. The main switch spring, subject to only 300° F. requires close tolerances. If too thick, it might take a set. If too thin it would lack sufficient contact pressure. Full hard Inconel strip .012″ x 3/8″ solves this problem.



The flat "K" Monel spring on the top casting of this fuse cutout holds the fuse under constant pressure against the upper coating. A coil spring, also "K" Monel, trips the fuse tube when the fuse blows. According to James R. Kearney Corporation "K" Monel springs "are well adapted to applications in heavy industrial areas subjected to a salt and sulphurous atmosphere."

For a more complete discussion of the valuable spring properties of various Inco Nickel Alloys, write for *66 Practical Ideas for Metal Problems in Electrical Products.* Address, please,

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

*Reg. U.S. Pat. Off.

WANT TO MAKE SOMETHING OF IT?

Pictured above is a tube of Taylor Laminated Phenol Fibre, just as it comes from our production line.

Pictured below is a coil form . . . quickly fabricated from this same tube. Note the precision of the punching and threading.

Sheets, rods, and tubes of Taylor Laminated Plastics possess so many properties, physical and electrical, of interest to industry . . . and adapt themselves to such a variety of fabrication processes . . . that their usefulness grows and grows and grows.

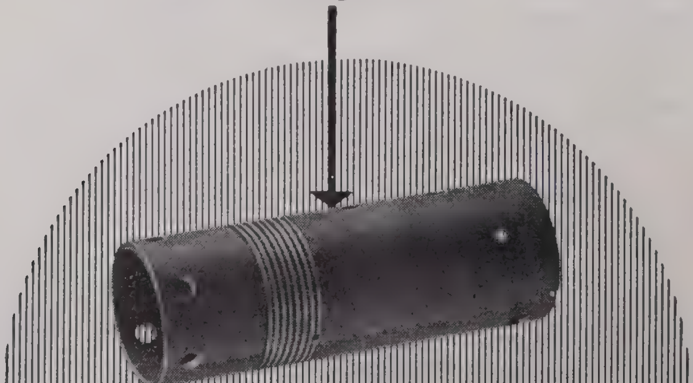
If you want a dependable source of supply for Phenol Fibre, Vulcanized Fibre, or special laminates . . . or if you're interested in having completed parts or sub-assemblies delivered on schedule at your plant . . . get in touch with Taylor. Send a sketch or blueprint, if you will, and we'll tell you exactly what we can do for you. Expect plenty; you won't be disappointed.

TAYLOR FIBRE COMPANY

LAMINATED PLASTICS: PHENOL FIBRE • VULCANIZED FIBRE • Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNA. Pacific Coast Plant: LA VERNE, CAL.

Offices in Principal Cities



SECTION MEETINGS

BEAUMONT-PORT ARTHUR

"Applications of Inverse Feedback," by L. W. Erath, Schlumberger Well Surveying Corporation; May 19, 1948.

"A Mobile Radio Telephone System," by E. F. Shawver, Southwestern Bell Telephone Company; June 10, 1948.

"Fire Department Communications," by J. R. Scroggs, City of Beaumont; July 20, 1948.

CEDAR RAPIDS

"Theory and Design of Electron Microscope," by W. H. Kohl, Collins Radio Company; June 23, 1948.

"Application of the Electron Microscope at Iowa State College," by P. H. Carr, Iowa State College; June 23, 1948.

EMPORIUM

"The Effect of Grid Contact Potential on Electron Tube Characteristics," by G. D. O'Neill, Sylvania Electric Products Inc.; August 13, 1948.

"Some Problems of Television," by B. E. Shackelford, President, The Institute of Radio Engineers; August 13, 1948.

"Electronic Computers," by D. L. Stevens, Sylvania Electric Products Inc.; August 14, 1948.

"A Direct Doubled Video and AGS System for Television Receivers," by H. R. Shaw, Colonial Radio Corporation; August 14, 1948.

MILWAUKEE

"Electron Theory of Diamagnetism and Paramagnetism," by A. E. Elo, Perfex Corporation; May 12, 1948.

"Electronics in Photography," by E. Farber, Strobo Research Laboratories; June 9, 1948.

Election of Officers; June 9, 1948.

NEW MEXICO

"Wartime Rocket Development," by H. G. Cooper, Los Alamos Scientific Laboratories; July 16, 1948.

PITTSBURGH

"Communications Theory," by W. G. Tuller, Melpar Inc.; May 10, 1948.

"Instruction and Research in Radio Engineering at Carnegie Tech," by W. M. Williams, Carnegie Institute of Technology; June 14, 1948.

Election of Officers; June 14, 1948.

PORTLAND

"A High-Speed Recorder for Use with Electronic Computers," by R. E. McCoy, Consulting Engineer; August 5, 1948.

SAN DIEGO

"European Broadcasting Before the Last War," by P. E. LeCorbeiller, Harvard University; August 3, 1948.

TOLEDO

"Institute Matters," and "Problems of Television" by B. E. Shackelford, President, The Institute of Radio Engineers; June 22, 1948.

Election of Officers; June 22, 1948.

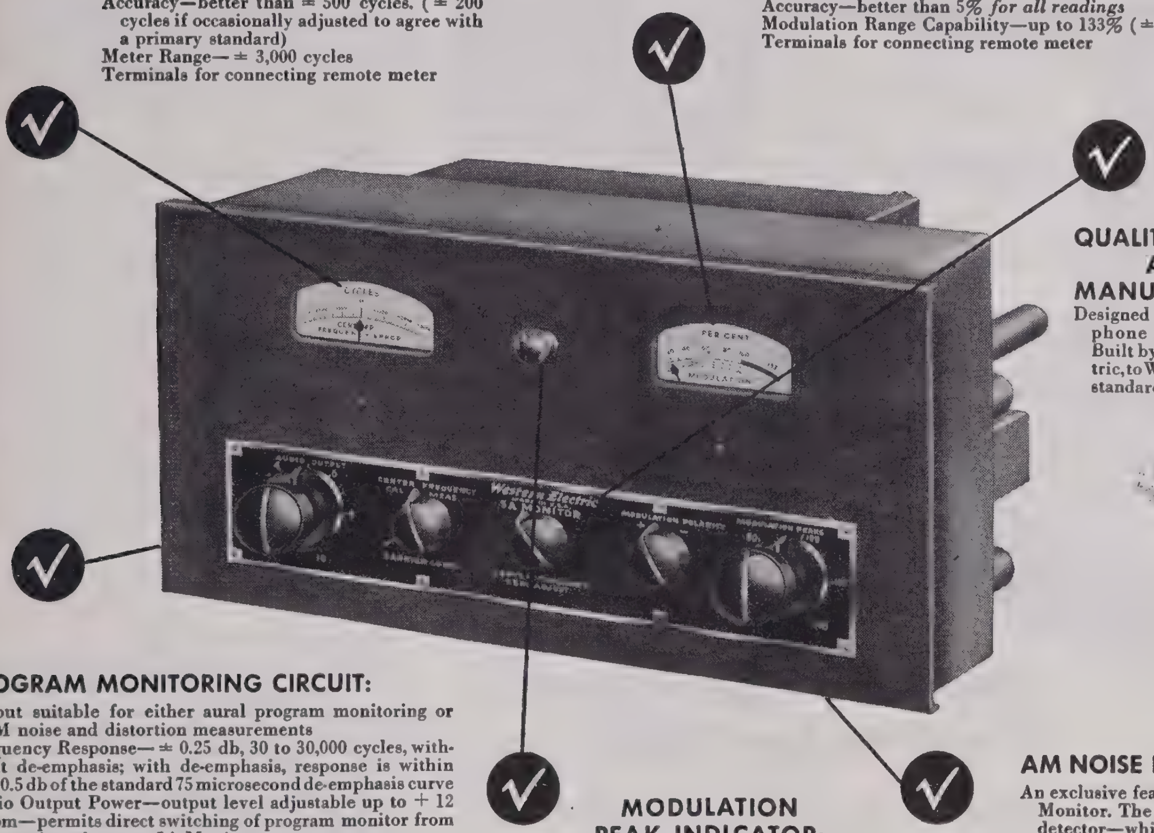
You get all these features ONLY in the *Western Electric 5A Monitor* for FM Broadcasting

CENTER FREQUENCY MONITOR:

Accuracy—better than ± 500 cycles. (± 200 cycles if occasionally adjusted to agree with a primary standard)
Meter Range—± 3,000 cycles
Terminals for connecting remote meter

MODULATION PERCENTAGE MONITOR:

Accuracy—better than 5% *for all readings*
Modulation Range Capability—up to 133% (± 100 kc)
Terminals for connecting remote meter



QUALITY DESIGN AND MANUFACTURE:

Designed by Bell Telephone Laboratories. Built by Western Electric, to Western Electric standards of quality.

PROGRAM MONITORING CIRCUIT:

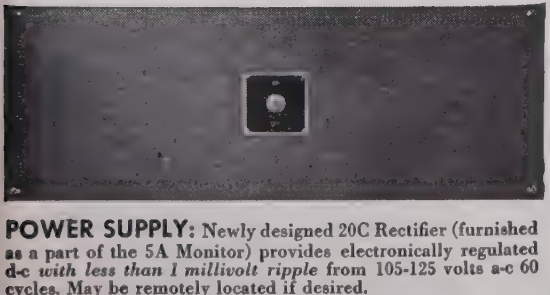
Output suitable for either aural program monitoring or FM noise and distortion measurements
Frequency Response—± 0.25 db, 30 to 30,000 cycles, without de-emphasis; with de-emphasis, response is within ± 0.5 db of the standard 75 microsecond de-emphasis curve
Audio Output Power—output level adjustable up to + 12 dbm—permits direct switching of program monitor from transmitter input to 5A Monitor output
Harmonic Distortion—*less than 1/4 of 1%* from 30 to 15,000 cps
Output Noise—at least 75 db below signal at 100% modulation

MODULATION PEAK INDICATOR:

Indication Lamp—flashes when a selected level of modulation is exceeded
Peak Limit Range—continuously adjustable between 40% and 140% modulation

AM NOISE DETECTOR:

An exclusive feature in the 5A Monitor. The output of this detector—which may be read directly on an electronic voltmeter or noise meter—is automatically referred to 100% amplitude modulation, thus simplifying measurement of transmitter AM noise.



POWER SUPPLY: Newly designed 20C Rectifier (furnished as a part of the 5A Monitor) provides electronically regulated d-c *with less than 1 millivolt ripple* from 105-125 volts a-c 60 cycles. May be remotely located if desired.

The 5A Monitor includes numerous other valuable features such as: dual thermostats and dual heaters for each crystal—means for checking the inherent noise level of the monitor from its *input to output terminals*—requires only a low RF input level (1 watt) which can vary from 0.3 to 3.0 watts; i. e., a 10 to 1 variation *without affecting the performance of the monitor.* To get the complete story on this outstanding monitor value, call your Graybar Broadcast Representative or mail the coupon below.

Western Electric

Distributors: In the U. S. A.—Graybar Electric Company.
In Canada and Newfoundland—Northern Electric Company, Ltd.

Distributed by GraybaR
OFFICES IN 98 PRINCIPAL CITIES

—QUALITY COUNTS—

Graybar Electric Company P-40
420 Lexington Avenue, New York 17, N. Y.

Please send me Bulletin T-2437, including curves, schematics and block diagram of the 5A Monitor.

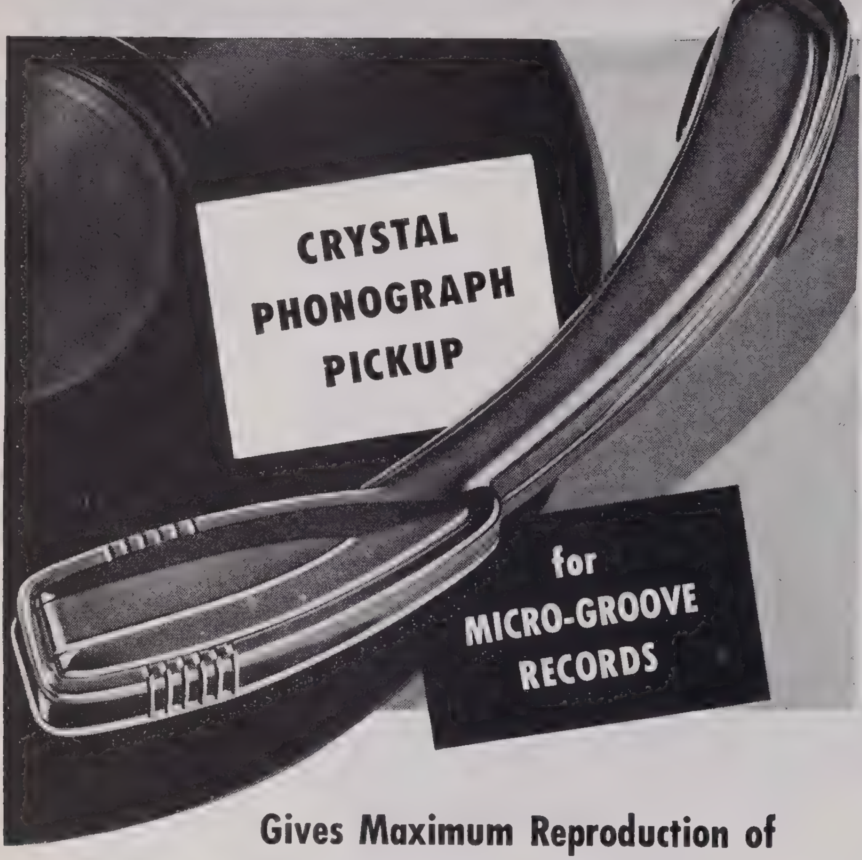
NAME______________________________

STATION____________________________

ADDRESS____________________________

CITY__________________STATE________

NEW SHURE "900MG"



Gives Maximum Reproduction of Micro-Groove Record Fidelity

The Shure "900MG" Pickup is an ideal instrument for tracking on the new micro-groove records. It tracks at 7 grams . . . has a needle force of 9 grams as added safety factor . . . uses a special offset osmium-tipped needle with a point radius of only .001" . . . and has an output of 1 volt! The Shure lever system has been adapted in the development of this new pickup—providing a high needle compliance. Listen to it—you will be thrilled with the results!

Model "900MG" Code: RUZUZ List Price: $12.50

Shure Patents Issued and Pending. Licensed under the Patents of the Brush Development Co.

SHURE

SHURE BROTHERS, Inc.
Microphones and Acoustic Devices
225 W. HURON ST., CHICAGO 10, ILL. • CABLE ADDRESS: SHUREMICRO

MEMBERSHIP

The following transfers and admissions were approved on September 8, 1948, to be effective as of October 1, 1948.

Transfer to Senior Member

Beagles, R., 11600 Sherman Way, North Hollywood, Calif.
Blaisdell, W. C., 846 Magie Ave., Elizabeth, N. J.
Greene, G. M., Electronics Test Division, Naval Air Test Center, Patuxent River, Md.
Herzog, E. F., Electronics Department, General Electric Co., Syracuse 1, N. Y.
Ludwig, J. H., 3 Whittlesey Rd., Newton Centre, Mass.
Nuckolls, R. G., Illinois Institute of Technology, 3300 Federal St., Chicago, Ill.
Onativia, J. M., c/o Servicio de Comunicaciones Navales, Darsena Norte, Buenos Aires, Argentina, S. A
Panter, P. F., 6 Hooper Ave., West Orange, N. J.
Parkes, A. W., Jr., 47 Cobb Rd., Mountain Lakes, N. J.
Paterson-Jones, E. A., Posts and Telegraphs Department, Box 581, Nairobi, Kenya, East Africa
Patterson, G. K., 2548 Ninth Ave., Sacramento 17, Calif.
Poch, W. J., 3 Haines Dr., Moorestown, N. J.
Renne, H. S., 14745 Main St., Harvey, Ill. (July 1, 1948)
Ross, A. H., Box 157, Shrewsbury, N. J.
Smith, C. R., Box 903, Alamogordo, N. Mex.
Swan, E. O., 271 Benson Ave., Toronto, Ont., Canada
Tuller, W. G., 4314 N. Henderson Rd., Arlington, Va.

Admission to Senior Member

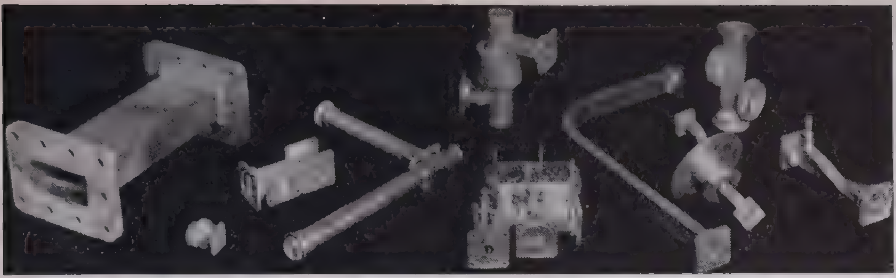
Gaudernack, L. F., Sorbyhaugen 4, Smestad, Pr. Oslo, Norway
Gunn, A. C., 173 Mosley Dr., Syracuse 6, N. Y.
Gutierrez, E. D., Bahia de Sta. Barbara 103, Mexico, D. F.
Hazen, H. L., Massachusetts Institute of Technology, Room 4-202, Cambridge, Mass.
Mawdsley, R. L., 1053 Superior Ave., Dayton, Ohio
McLaughlin, K. M., Victor Division, RCA Laboratories, Harrison, N. J.
Pascucci, A. A., c/o Radio Hispano Suiza, Calle Fernando Puig 49, Barcelona, Spain

Transfer to Member Grade

Adams, G. J., 299 Atlantic Ave., Boston, Mass.
Apte, B. M., Mallick Bldg., Shivajee Park Rd., No. 4, Bombay, India
Baer, J., Box 4150, Tel Aviv, Palestine
Barron, F. E., 3001 Chowen Ave. N., Minneapolis, Minn.
Bhargava, B. N., Sadabad, Dist. Mathura, U.P., India
Chiang, F. Y. K., Sung Sing Cotton Mill No. 9, 140 Macao Rd., Shanghai, China
Clelland, F. W., Jr., Box 1199, Stanford University, Calif.
Congdon, R. L., 6000 Lemmon Ave., Dallas, Tex.
Cowan, E. J., 69 Edgewood Ave., Springdale, Conn.
Crossan, G. W., 191 St. Germain Ave., Toronto, Ont., Canada
Dana, J. J., 5130 Sylvanite Dr., San Diego, Calif.
Deeter, C. R., 5725 N. Washington Blvd., Arlington, Va.
Dewan, R. N., 5, Doctor's Lane, New Delhi, India
Eastwood, G. C., 16 The Aberdeens, Bain Ave., Toronto, Ont., Canada
Erznoznik, F., Jr., 3508 W. 12 Pl., Chicago, Ill.
Falk, A. E., 3700 E. Pontiac, Fort Wayne, Ind.
Foulon, F., 547 N. Sierra Bonita Ave., Los Angeles, Calif.

(Continued on page 38A)

MICROWAVE PLUMBING



10 CENTIMETER

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated $45.00
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. New and complete $135.00
10 CM. END-FIRE ARRAY POLYRODS ...$1.75 ea.
"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output $3.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers $5.50
10 CM. McNALLY CAVITY Type SG $3.50
WAVEGUIDE SECTION. MC 445A, rt. angle bend, 5½ ft. OA. 8" slotted section $21.00
10 CM OSC. PICKUP LOOP, with male Homedell output $2.00
10 CM. DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fitting $4.50
10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola $8.00

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple $2.00
RIGID COAX to flex coax connector $3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00
⅞" COAX. ROTARY JOINT $8.00
RT. ANGLE BEND 15" L. OA $2.00
FLEXIBLE SECTION, 15" L. Male to female ..$4.25
MAGNETRON COUPLING to ⅞" rigid coax ⅜" IC line, less "M" nut, with TR pickup loop, gold plated $7.50

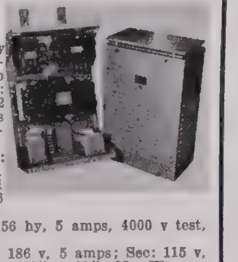
⅞" RIGID COAX—¼ I.C.

SHORT RIGHT ANGLE BEND $2.50
ROTATING JOINT, with deck mounting $5.00
RIGID COAX slotted section CU-60/AP $5.00

1.25 CENTIMETER

MITRED ELBOW cover to cover $4.00
TR/ATR SECTION choke to cover $4.00
FLEXIBLE SECTION 1" choke to choke $5.00

VOLTAGE REGULATORS



Mfg. Raytheon: Navy CRP-301407: Pri: 92-138 v, 15 amps, 57 to 63 cy, 1 phase. Sec: 115 v, 7.15 amp, .82 KVA, .96 PF. Contains the following components:
Regulator Transformer: Raytheon UX-9545. Pri: 92-138 v, 60 cy, 1 PH Sec: 200/5 5.5/5.26 amps, 400 v rms test.
FILTER REACTOR: 156 hy, 5 amps, 4000 v test, Raytheon UX 9547.
TRANSFORMER: Pri: 186 v, 5 amps; Sec: 115 v, 7.2 amps. Size: 12" x 20" x 29". Net Wt. approx. 250 Lbs.
Entire unit is enclosed in grey metal cabinet with mounting facilities. New, as shown $99.50

POWER EQUIPMENT

STEP DOWN TRANSFORMER: Pri: 440/220/110 volts a.c. 60 cycles. 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7" $40.00
PLATE TRANSFORMER. Pri: 117 v. 60 cy. Sec. 17,600 v. @ 144 ma, with choke. Oil immersed. Size: 26" x 29" x 13". Amertran $65.00
FIL. TRANSFORMER: Pri: 220 v.a.c., 60 cy; .05KVA. Sec. 5 v.c.t., 34,000 v. test $24.50
FIL. TRANS. UX6899. Pri: 115 V, 60 cyc. Sec: Two 5 v, 5.5 amp wdgs. 29KV Test $24.50
PLATE TRANSFORMER: Pri: 115/230 v.a.c., 50-60 cy Sec: 21,000 v. 100 ma $120.00
"TRANSTAT" VOLTAGE REG. 11.5 KVA, 0-115 vac. 60 cy, 100 amps $75.00
VOLTAGE REG Transtat. Amertran type RH 2 KVA load, input: 90/130 V. 50-60 cy output 115 v..$40.00
ITE CIRCUIT BREAKER. 115 A, 600 V $15.00

COAX CONNECTORS

831R	$.35	**UG 21/U**	$.85
831SP	$.35	**UG 86/U**	$.95
831AP	$.35	**UG 254/U**	$.75
831HP	$.15	**UG 255/U**	$1.25

Homedell male to type "N" male adapter $1.25

3 CM.

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

"X" BAND WAVEGUIDE, 1¼" x ⅝" OD, 1/16" wall, aluminum ....per ft. $ .75
WAVEGUIDE, 1" x ½" I.D. per ft. $1.50
TR CAVITY for 724-A TR tube, transmission or absorption types $3.50
3" FLEX SECTION, square flange to circular flange adapter $7.50
724 TR tube (41-TR-1) $2.50
WAVEGUIDE SECTION, CG 251/APS-15A, 26" long choke to cover, with 180 deg. bend of 2½" rad. at one end $6.00
ROTARY JOINT with slotted section and type "N" output pickup $8.50
WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2½" radius, 90 deg. bend $4.50
STABILIZER CAVITY feeding waveguide section, with filtered output and attenuating slugs $20.00
SLUG, TUNER/ATTENUATOR, W.E. guide, gold plated $6.50
TR/ATR DUPLEXER section with iris flange ...$4.50
TWIST 90 deg., 5" choke to cover $5.00
WAVEGUIDE SECTIONS 2½ ft. long, silver plated, with choke flange $5.75
WAVEGUIDE, 90 deg. bend E plane, 18" long ..$4.00
ROTARY JOINT, choke to choke $6.00
ROTARY JOINT, choke to choke, with deck mounting $6.00
S-CURVE WAVEGUIDE, 8" long cover to choke $3.50
DUPLEXER SECTION for 1B24 ....$10.00
CIRCULAR CHOKE FLANGES, solid brass .... .55
"T" SECTION (TR-ATR) choke to choke, supplied with circ. or sq. flanges $3.50

APS-10 2K25/723AB, X band local oscillator mount with (1) choke coupling to beacon reference cavity; (2) choke coupling to TR and receiver; (3) Iris coupling with AFC attenuator to antenna waveguide; (4) Radar AFC crystal mount; (5) Receiver crystal mount; (6) Attenuating slugs. Mfg. DeMornay, Budd $22.50
TR/ATR Duplexer section for above $4.00

2½" FLEXIBLE SECTION, cover to cover $4.00
SHORT ARM "T" section, with additional choke output on vertical section $4.00

KBAND Rotary joint $45.00
ADAPTER, rd. cover to sq. cover $5.00
MITRED ELBOW and S sections choke to cover .$4.50

LABORATORY ACCESSORIES

COAX CABLE

RG 18/U, 52 ohm im. armored ....$ .51/ft.
RG 23/U, twin coax, 125 ohm imp. armored $ .50/ft.
RG 28/U, 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV ....$ .50/ft.
RG 35/U, 70 ohm imp. armored ....$ .50/ft.

VARISTORS W.E.

D-171121	$.95	D-168549	$.95
D-171631	$.95	D-162482	$3.00
D-167176	$.95	D-99136	$1.65
D-170225	$.95	D-166271	$2.50
D-168687	$.95	D-162356	$1.50
D-171812	$.95	D-161871A	$2.85
D-171528	$.95	D-99946	$2.00
D-163298	$.95		

THERMISTORS—W.E. $.95 Each

D-167332 (bead)	D-166228 (button)
D-170396 (bead)	D-166382 (tube)
D-167613 (button)	D-167018 (tube)

DECADE RESISTANCE BOX. 0-1250 ohms in 250-ohms steps $2.50
DECADE CAPACITOR. .0054 mfd in 8 steps, $2500 v. ins. CD # PL 1165-120. 8" x 5¼" diam. $6.50
"PPI," **ROTATING YOKE TYPE.** Complete with all necessary oscillator circuits, CR tube 5FP7, complete with tubes. Used with SO radar $100.00
SPERRY KLYSTRON TUNER Mod. 12 ....$2.00
SINE POTENTIOMETERS, GE#251x96 or W.E. #KS 15138 LO1 ....$3.50
CG 27 TYPE "N" CABLE ASS'Y, 3' long, male to female $2.50
PH-SHIFTING CAP. 180 deg. W.E. #D-150734 $2.50
KLYSTRON SOCKETS for 723 A.B. and similar types 2 for $1.00
LINE INSERTION ATTENUATOR, type OAX-1. 20 Db. attenuation, with 3-contact plug and socket (amphenol 16S-5) $2.25

400 CYCLE TRANSFORMERS

2419: Pri: 115 v. 400 cy. Sec: 6.3 v, 2.7 amp: 6.3 v, .66 amp; 6.3 v, 21 amp $2.95
32332: Pri: 115 v, 400-2400 cy. Sec: 400 vct, 35 ma; 6.4 v, 2.5 amp; 6.4 v, .15 amp $2.25
352-7179: Pri: 115 v, 400-2400 cy. Sec: 6.5 v, 12 amp ct. 250 v, 100 ma; 5 v, 2 amp $3.50
#9069: Pri: 115/80 v, 400-2600 cy. Sec: 650 vct, 50 ma; 6.3 vct, 2 amp; 5 vct, 2 amp $2.15
352-7096: Pri: 115/80 v, 400-2400 cy. Sec: 2.5 v, 1.75 amp; 3KV ins; 5 v, 3 amp; 6.5 v, 6.5 amp; 6.5 v, 1.2 amp $3.95

INVERTERS

PE 206-A: Input: 28 VDC @ 38 amp. Output: 80 volts @ 500 volt-amps, 800 cycles. Leland. New, complete with enclosed relay, filter, instruction book ..$12.50
PE 218: Input: 25-28 VDC @ 92 amps. Output: 115 volts @ 1500 volt-amps, 380-500 cycles. Poor physical but good running condition $15.00

MICRO WAVE GENERATORS

AN/APS-15A "X" Band compl RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc & beacon), 1B24 TR, rcvr-ampl, duplexer, HV supply, blower, pulse xfmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV Pk Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's Compl pkg, new $210.00
APS-15B. Complete pkg. as above, less modulator $150.00

"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A mixer, TR, receiver, duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00

10 CM, RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer $150.00
Modulator-motor-alternator unit for above .$ 75.00
Receiver-rectifier power unit for above ....$ 25.00
Rotating antenna with parabolic reflector for above. New $75.00

MAGNETRONS

TUBE	FRQ. RANGE PK.	PWR. OUT.	PRICE
2J31	2820-2860 mc.	265 KW.	$15.00
2J21-A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$15.00
2J26	2992-3019 mc.	275 KW.	$15.00
2J27	2965-2992 mc.	275 KW.	$15.00
2J32	2780-2820 mc.	285 KW.	$15.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267-3333 mc.	8.7 KW.	$25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	$25.00
3J31	24,000 mc.	50 KW.	$35.00
5J30			$39.50
714AY			$15.00
720BY	2800 mc.	1000 KW.	$50.00
725-A			$25.00
730-A			$25.00

KLYSTRONS: 723A/B $12.50 707B W/CAVITY $20.00

MAGNETS

For 2J21, 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31 ....Each $8.00
4850 Gauss, ⅝" bet. pole faces, ¾" pole diam. .$8.00
1500 Gauss, 1½" bet. pole faces, 1⅝" pole diam. $8.00

TUNABLE PKG'D "CW" MAGNETRONS

QK59 2675-2900 Mcs.
QK60 2800-3025 Mcs.
New—$45 each

QK61 2975-3200 Mcs.
QK62 3150-3375 Mcs.
New—$55 each

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS. Sweep time 100 to 2500 microsec. in 4 steps, fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Sliding pulse variable in phase up to 2500 microsec. Amplitude of suppression pulse adjustable between 10 and 35 v. and width variable between the limits of 10 microsec. or less to 1800 microsec. or more at a recurrence rate between 200 and 300 cps. Provides various types of voltage pulse outputs for modulation of a signal generator such as GR #804B or 804C. New.... ....$125.00

MIT MODEL 3 HARD TUBE PULSER

Output Pulse Power: 144 KW (12 KV at 12 amp). Duty Ratio: .001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses 1-715-B, 1-829-B, 3-'72's, 1-'73. New $110.00
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules $49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk): pulse rate 200 PPS, 1.5 microsec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v, 400 cycle input. New, with all tubes $49.50

PULSE TRANSFORMERS

W.E. # D166173 HI-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $12.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $2.00
G.E. # K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28KV PK. Peak Output: 800 KW Bifilar 2.75 Amp. $19.50
G.E. K2450A Will receive 13KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100W GE $15.00
W.E. # D169271 Hi Volt input pulse Transformer $9.95
G.E. # K2748A Pulse Input. line to magnetron $12.00
UTAH PULSE OR BLOCKING OSCILLATOR Transformer Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅞" 19/32 ....$1.50

PULSE NETWORKS

G.E. #25E5-1-350-50P2T. 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 ohms impedance $45.00
G.E. #6E3-5-2000-50 P2T. 6KV, "E" circuit, 3 sections, .5 micro-second pulse, 2000 PPS, 50 ohms impedance $6.50

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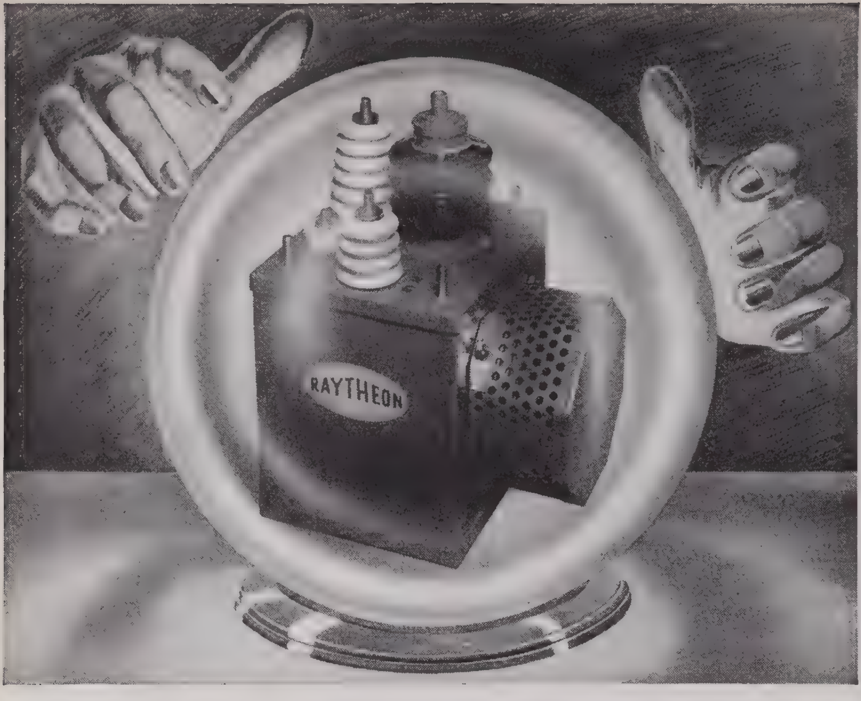

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Raytheon can furnish custom-engineered transformers designed to fit *your* special needs . . . in the size, type and quantity you require. As one of the oldest and largest producers, Raytheon has the experience and facilities to design, test and deliver transformers that you can incorporate in your product or equipment with complete confidence.

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Hale, R. C., 24 Reed St., Lexington, Mass.
Higgs, R. E., 315 N. 12 St., Newark, N. J.
Hobday, S. W., 265, Malden Way, New Malden, Surrey, England
Immen, G. H., 2835 Bainbridge Ave., New York, N. Y.
Inderwiesen, F. H., Jr., 1116 West 40 St., Kansas City, Mo.
Joshi, C. P., "The Castle," Almora, U.P., India
Lane, C. A., Jr., 4104 Harrison St., Kansas City, Mo.
Lee, P. H., Box 77, Maple Ave., Demarest, N. J.
Lichi, J. S. Ometusco 46, Mexico, D. F.
Marsden, B., c/o A. R. Sugden & Co. Ltd., 36 Wellgreen Lane, Brighouse, Yorkshire, England
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Miller, R. H., Jr., 829 Sutter St., San Diego, Calif.
Nelson, R. H. E., Swedish Western Electric Co., A.B., Sveavagen 25-27, Stockholm, Sweden
Pomy, H. J., Hqts. Signal Service, USARPAC, APO 958, c/o Postmaster, San Francisco, Calif.
Reese, H., Jr., 267 Virginia Ave., Rochester, Pa.
Rosenberg, J., 191 Sandford St., New Brunswick, N. J.
Rowe, I., 594 E. 93 St., Brooklyn, N. Y.
Smillie, P. V., Reme Training Centre, Arborfield, Berks., England
Smith, P. J., 113 E. Conklin Ave., Nedrow, N. Y.
Snell, P. A., c/o Electronic Tube Co., 1200 E. Mermaid, Philadelphia, Pa.
Snyder, W. W., 40-22 Lawrence St., Flushing, L. I., N. Y.
Stolze, W. J., 20-64—33 St., Astoria, L. I., N. Y.
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Surtees, W. J., 150 Metcalfe St., Ottawa, Ont., Canada
Trafford, W., Telecommunications Department, Kuala Lumpur, Malaya
Tullos, F. N., 212A Humble Bldg., Houston, Tex.
Whyte, J. R., 74 Summerhill Ave., Toronto, Ont., Canada.
Willey, F. G., Box 533, Babylon, L. I., N. Y.
Williams, F. H., Hazeltine Electronics Corp., Little Neck, L. I., N. Y.
Williams, I. J. S., 13 Rutherglen Ave., Whitley, Coventry, England
Wilson, B. J., 212 Electrical Engineering Laboratory, University of Illinois, Urbana, Ill.
Zaret, M. E., 3941—48 St., Long Island City, L. I., N. Y.

Admission to Member Grade

Acree, A. J., 66 N. Bromfield Rd., Dayton, Ohio
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Cook, R. H., 5236 N. Bernard St., Chicago, Ill.
Ferguson, J. C., Jr., 5215 Linden St., Mission, Kan.
Foster, C. E., Quarters 207-B, 13 St., Sandia Base Branch, Albuquerque, N. Mex.
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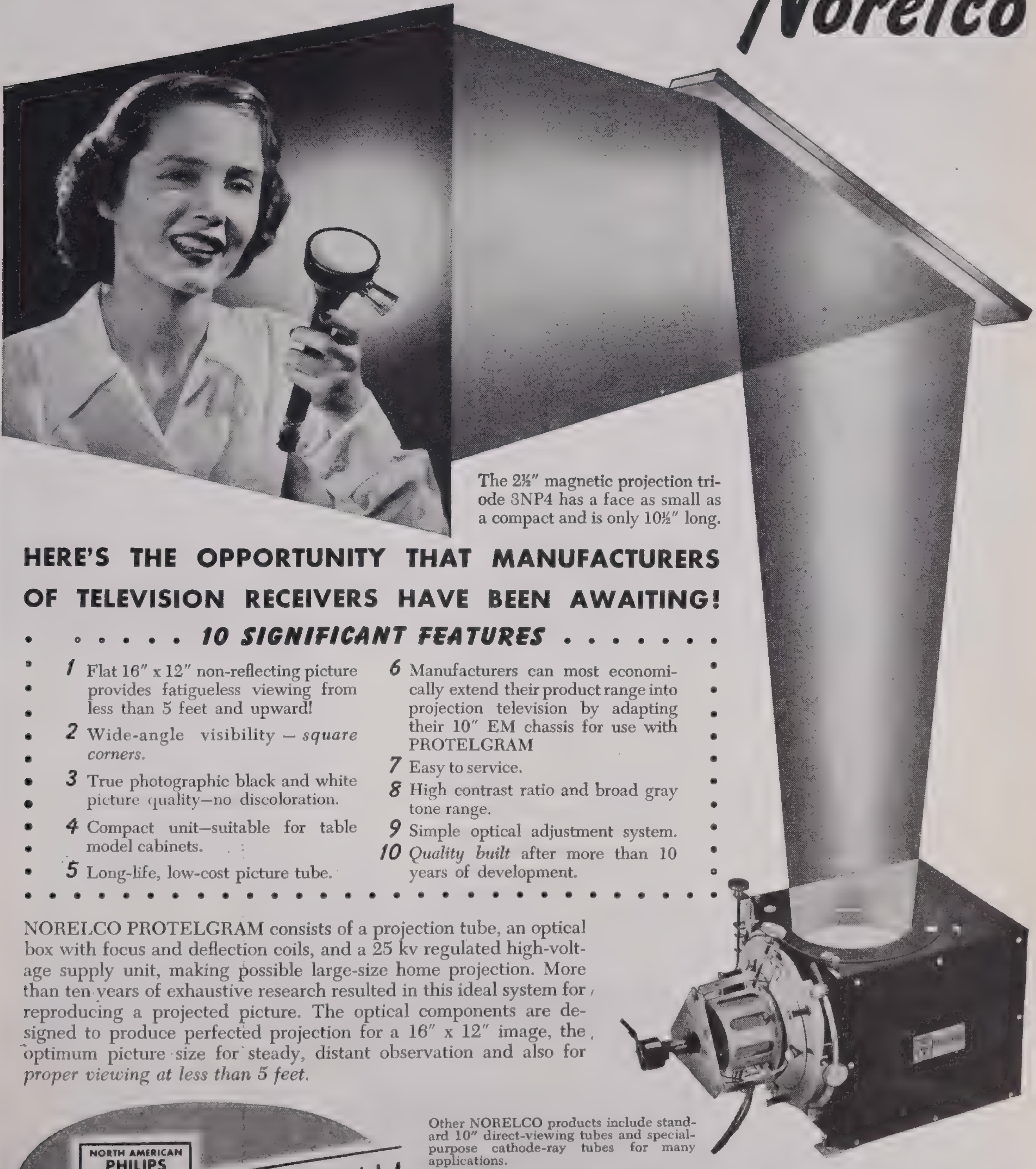
Hughes, L. J., 126 Edgeley Rd., P.O. Red Hill, Durban, S. Africa
Kuhn, D. H., 144 Jay St., Schenectady, N. Y.
Meichner, F. T., 28-43—37 St., Long Island City, L. I., N. Y.

(Continued on page 40A)

PICTURE PROJECTION

Perfected by *Norelco*



The 2½″ magnetic projection triode 3NP4 has a face as small as a compact and is only 10½″ long.

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10 SIGNIFICANT FEATURES

1. Flat 16″ x 12″ non-reflecting picture provides fatigueless viewing from less than 5 feet and upward!
2. Wide-angle visibility — *square corners.*
3. True photographic black and white picture quality—no discoloration.
4. Compact unit—suitable for table model cabinets.
5. Long-life, low-cost picture tube.
6. Manufacturers can most economically extend their product range into projection television by adapting their 10″ EM chassis for use with PROTELGRAM
7. Easy to service.
8. High contrast ratio and broad gray tone range.
9. Simple optical adjustment system.
10. *Quality built* after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated high-voltage supply unit, making possible large-size home projection. More than ten years of exhaustive research resulted in this ideal system for reproducing a projected picture. The optical components are designed to produce perfected projection for a 16″ x 12″ image, the optimum picture size for steady, distant observation and also for *proper viewing at less than 5 feet.*

Other NORELCO products include standard 10″ direct-viewing tubes and special-purpose cathode-ray tubes for many applications.

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Norelco

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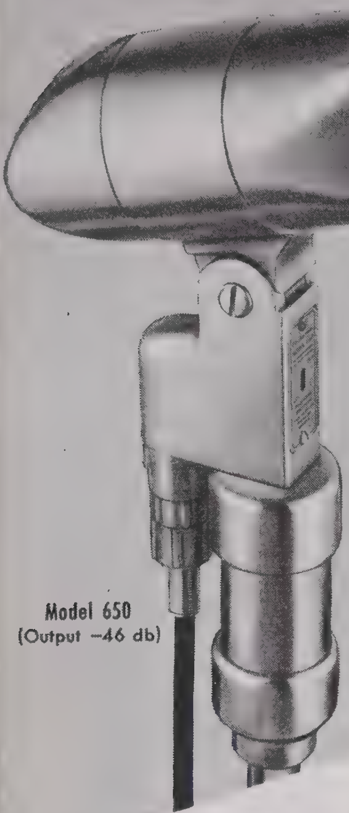

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High Fidelity Dynamic

E-V BROADCAST Microphones

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WIN *TOP RATING*

by Station and Network Engineers!

Flat out to 15 kc! Extremely high output! Impedance selector! Dual-type shock-mount! Remarkably rugged! Individually calibrated!

Developed in cooperation with station and network engineers, the new "650" and "645" meet exacting requirements of modern high fidelity FM and AM broadcast service. Proved in studio and remote use. Polar pattern is non-directional at low frequencies, becoming directional at high frequencies. Recessed switch gives instant selection of 50 or 250 ohms impedance. Exclusive Acoustalloy diaphragm withstands toughest use. Many other important features assure the ultimate in broadcast quality. Satin chromium finish. Fully guaranteed.

Model 650. Output level —46 db. List........**$150.00**
Model 645. Output level —50 db. List........**$100.00**

Broadcast Engineers: Put the "650" or "645" to the test in your station. Know the thrill of using the newest and finest. Write for full details.

Model 645
(Output −50 db)

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(Continued from page 38A)

Moore, G. E., 1727 New Haven Ave., Pittsburgh, Pa.
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Pollack, I., 178 Mackenzie St., Brooklyn, N. Y.
Richardson, F. L., 6 Loring Rd., R.F.D. 2, Hicksville, L. I., N. Y.
Smoll, L. A., 412½ S. Yale Ave., Albuquerque, N. Mex.
Stautner, P. L., 223 N. Espanola Ave., Albuquerque, N. Mex.
Thomas, E. W., 1819 Monroe St., N.W., Washington, D. C.
von Kunits, P., 149-27—19 Ave., Whitestone, N. Y.

The following admissions to Associate grade have been approved and will be effective as of September 1, 1948.

Andrews, F. B., Jr., 104 E. Second St., Emporium, Pa.
Banerjee, Bhabanath, School of Radio Physics and Electricity, S. P. College, Poona, India
Barrett, D. D., 681 Rockdale Dr., San Francisco 16, Calif.
Bartel, Baity, 4818 Ash Lane, Dallas 10, Tex.
Bell, H. J., 6925-A Passaic, Huntington Park, Calif.
Chavez, J. S., 4606—16 St., N.W., Washington 6, D. C.
Corbett, L. E. A., 31 Kingston Ave., Mt. Roskill, Auckland, New Zealand
Cozier, J. R., 29 S. Munn Ave., East Orange, N. J.
Donohoe, T. K., Box 579, Anchorage, Alaska
Felsecker, R. E., 2135 S. Fern St., Arlington, Va.
Gannett, Ernest, 172 Brook Ave., Oakwood Heights Staten Island 6, N. Y.
Gordon, H. L., 2030—46 Ave., San Francisco 16, Calif.
Green, C. S., R.F.D. 1, Box 179A, Eureka, Mo.
Guidotti, J. D., 443 N. 29 St., Milwaukee, Wis.
Haymes, Irving, 215—109 Ave., Elmont, L. I., N. Y.
Hellinger, H. R. J., Idelson St., Tel-Aviv, Palestine
Herb, J. W., 4173 Oakridge Dr., Dayton 7, Ohio
Herrmann, N. P., 6267 S.W. 12 St., Miami, 35 Fla.
Jameson, F. P., Box 42, Butte, Mont.
Kernkamp, C. F., 1807 Elizabeth Ave., Winston Salem, N. C.
LaFleur, R. S., 405 N. Superior St., Angola, Ind.
Lawton, L. M., Jr., Thompson Physical Laboratory, Williamstown, Mass.
Lucier, O. S., 130 Russell Ave., Rahway, N. J.
Mallon, R. H., 2695 Euclid W., Detroit 6, Mich.
Mason, J. B., R.F.D. 1, Warner, N. H.
Mausler, Robert, 50-16—213 St., Bayside, L. I., N. Y.
Miller, E. C., Box 1137, Kodiak, Alaska
Morris, H. R., 22 Elsmere Rd., Kimberley, Northern Cape, South Africa
Morrison, D. A., R.F.D. 1, Niagara Falls, N. Y.
Owens, D. L., Box 1679, Houston 1, Tex.
Parson, M. R., 1549—17 St., Des Moines 10, Iowa
Poole, A. L., 835 Turk St., San Francisco 1, Calif.
Preti, L. L., 220 Roseville Ave., Newark 7, N. J.
Rao, M. R, Mysore Chemical and Soap Works, Sion, Bombay, India
Richman, P. L., 12 E. 86 St., New York 28, N. Y.
Seshu, Sundaram, "Svagatam," 99, V. M. St., Mylapore, Madras, S. India
Simons, F. A., Jr., 220 S. Pannes Ave., Compton, Calif.
Vargas, Arnoldo, 1365 Columbia Rd., N. W., Washington, D. C.
Venkateswaran, Sankara, All India Radio, Parliament St., New Delhi, India
Weinstock, W. W., 3229 N. 17 St., Philadelphia 40, Pa.
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(Continued on page 40A)

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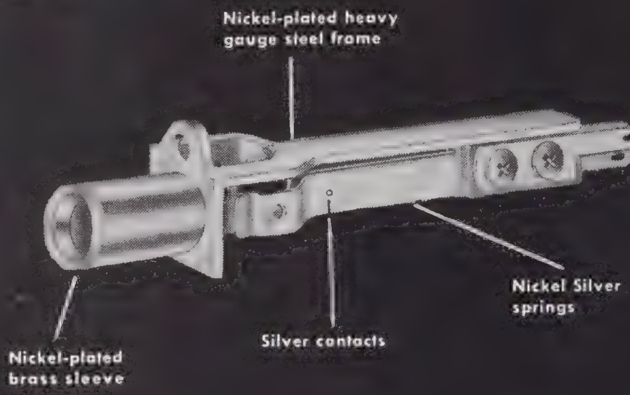
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MEMBERSHIP

(Continued from page 40A)

Wolfendale, F. C., 43 Elmbank Way, Hanwell London, England
Young, C. E., Box 125, Madison, Wis.
Zavoda, J. P. 209 Sherman, St., Boonton, N. J.

The following transfers to Associate grade were approved and will be effective as of September 1, 1948:

Achramowicz, M. J., 65 Houghton St., Worcester 4, Mass.
Berkowitz, R. S., 3321 Powelton Ave., Philadelphia, Pa.
Dille, A. C., 1531 Leavenworth St., Manhattan, Kans.
Ethridge, N. H., 729 Spring St., N. W., Atlanta 3, Ga.
Feldman, S., c/o L. T. Huntington, Service Engineering Division, General Electric Company, Schenectady, N. Y.
Finch, W. H., c/o Director of Signals, Army Headquarters, Ottawa, Ont., Canada
Harmon, W. R., Jr., Box 85, N. Wilkesboro, N. C.
Harris, H. E., 274 Forest Hill Dr., Syracuse, N. Y.
Hayden, J. O., Bill's Trailer Park, N. Syracuse, N. Y.
Hill, C. R., 849 Hinta St., Evanston, Wyo.
Hoyt, E. M., 20 Plow Lane, Levittown, Hicksville, N. Y.
Jensen, A. C., R. R. 12, Box 380, Milwaukee, Wis.
Keyes, D. H., 231 Ocean Ave., Lynbrook, N. Y.
Knoll, D. W., 2519 Kecoughtan Rd., Hampton, Va.
Mazer, W. M., 138 Neptune Ave., Brooklyn 24, N. Y.
McCracken, L. G., 919 S. Pugh St., State College, Pa.
Mishra, S., Amalapare, Fifth Line, P. O. Angul, Orissa, India
Morrison, S. M., 1414 Eighth Ave., Marion, Ia.
Pearson, S. S., 2585 Rosewood Ave., Roslyn, Pa.
Rummel, E. C., 400 W. 34 St., Austin, Tex.
White, E. A., 3021 Weisser Park Ave., Fort Wayne, Ind.
Williams, W. A., 16 Columbine Rd., Worcester 2, Mass.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 24A)

New Enterprises

The **Spencer-Kennedy Labs., Inc.,** 10 Follen St., Cambridge 38, Mass., has recently been formed to develop and manufacture precision scientific instruments.

The first instrument to go into production is the Model 400-A bridge controlled thyratron thermostat for temperature control.

Two types of control are possible with the thermostat: (1) by the resistance thermometer method; (2) by the change of resistance of the heater winding itself.

With a properly designed heating unit, temperatures from 20°C. to 1200°C. can be maintained with an accuracy of $\pm 0.1\%$ by the first method and $\pm 0.5\%$ by the second method.

(Continued on page 49A)

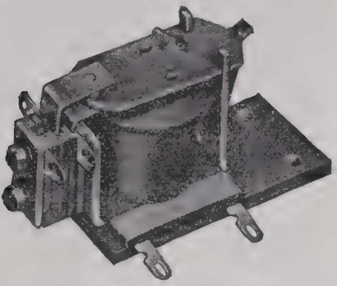
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 42A)

New Compact DC Relay

A sensitive dc relay designed primarily for electronic tube circuits, alarm systems and other similar applications, the type "E", is being marketed by the **Comar Electric Co.,** 3148 N. Washtenaw Ave., Chicago 18, Ill.



It is a single-pole, double-throw relay with a contact capacity up to 5 amperes at 25 volts noninductive load.

The power consumption is 60 milliwatts, and the overall size is $2\frac{1}{2}'' \times 2\frac{1}{4}'' \times 1\frac{1}{3}''$.

Tri-Purpose Air Meter

Anemotherm, an air meter which measures air velocity, air temperature, and static pressure, is now being manufactured by **Anemostat Corp. of America,** 10 East 29 St., New York 6, N. Y.

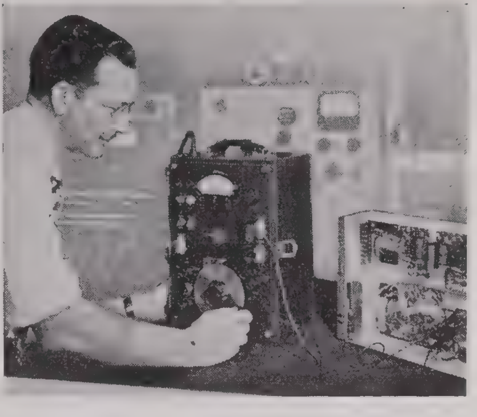
This meter measures air velocity from 10 fpm to 5000 fpm; temperatures from 30°F to 155°F; positive or negative static pressure in inches of water from 0.05 to 10 positive and 0.05 to 4 negative.

Since it can accurately measure velocities as low as 10 fpm, regardless of direction of air flow, the Anemotherm detects even the slightest drafts, and can provide data on low air movement of a turbulent nature.

Operation is from self-contained batteries and the meter is portable, since it weighs 11 pounds.

(Continued on page 59A)

Z-ANGLE METER'S OUTSTANDING
ACCURACY-SPEED-SIMPLICITY
PLEASES LANGEVIN ENGINEERS



Langevin engineers say, ". . . the plate impedance of a resistance coupled triode tube can be determined by taking a reading with the Z-Angle meter at the output terminals and then extracting the unknown from the mathematical formula for the impedances in parallel. This is only one of the many uses we have found for this instrument."

Write today for Bulletins on the Z-Angle Meter, R-F Z-Angle Meter, R-F Oscillator and Precision Variable Resistors.

Read this interesting statement:

"The Langevin Manufacturing Corporation Development Laboratory finds the Z-Angle meter extremely useful in the determination of transformer impedances. In the manufacture of amplifiers it is often necessary to determine the impedances existing within amplifier stages. Heretofore, these determinations have involved a long drawn out test procedure. The Z-Angle meter, however, allows readings to be made accurately and quickly."

The Z-Angle Meter is a modern, self-contained instrument for making quick, accurate measurements of impedance and phase angle vs. frequency.

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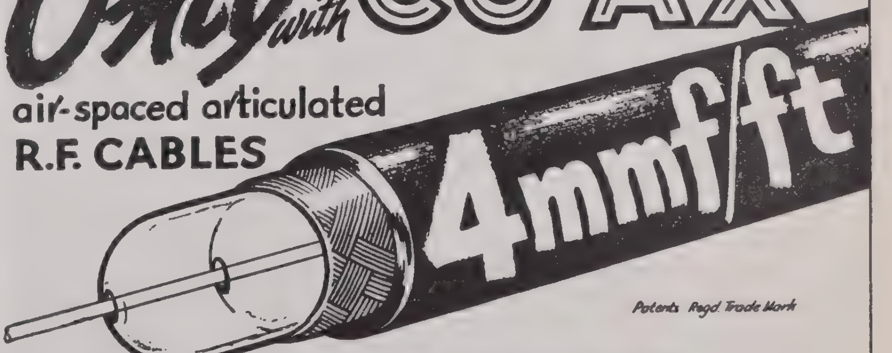

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A 2	74	1.3	0.24	0.44	HIGH POWER FLEXIBLE
A 34	73	0.6	1.5	0.88	

LOW CAPAC TYPES	CAPAC mmf/ft.	IMPED OHMS	ATTEN db/100ft 100Mc/s.	O.D."	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C 33	4.8	220	2.4	0.64	V.L.C. ★
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The Naval Ordnance Laboratory located just outside of Washington, offers many advantages to engineers and physicists. Openings exist in the fields of electronics and complex mechanisms. The laboratory is provided with the best equipment. Men capable of developing complex electronic circuits or with experience in electronic instrument design are particularly desired. Salaries range from P-4—$4,903 and higher, to P-2—$3397.20. Interested applicants are urged to communicate with Engineering Dept., Naval Ordnance Laboratory, White Oak, Maryland.

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Graduate electrical engineer with several years experience in audio development work, preferably magnetic recording, wanted for design work. Unusual opportunity for permanent position for the right person with long established company. Vicinity New York City. Reply giving résumé of personal data, educational background, experience and salary desired. Write I.R.E. 1699, 113 W. 42 St., New York 18, N.Y.

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Scientific research, development and engineering positions at the National Bureau of Standards, Washington, D.C., are available in the fields of physics, electronics engineering, radio engineering, mechanical engineering and mathematics. Salary range from $3397 per annum through $8179, depending upon qualifications. Qualified scientists are invited to communicate with Personnel Officer, Division 13, National Bureau of Standards, Washington 25, D.C.

RESEARCH SCIENTISTS

Scientific research and development positions at the Naval Research Laboratory, Washington, D.C., are open in the fields of physics, mathematics, engineering (including electronics, radio, electrical, mechanical, chemical, metallurgical, etc.). A B.S. degree in the appropriate field from an accredited college or university is essential. Advanced academic standing and pertinent research experience is desirable. Opportunities for graduate study are offered at NRL. Qualified scientists are invited to communicate with Employment Officer, Code 1811 (I) Naval Research Laboratory, Washington 20, D.C.

(Continued on page 51A)

WANTED
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AND
PHYSICISTS

Excellent opportunities for graduates with research, design, and/or development experience in Communications and aerial navigation systems including direction finders, radar, FM, television, micro-wave.

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Salaries commensurate with experience and ability. Excellent opportunities for qualified personnel.

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Akron 15, Ohio

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 49A)

Circle Template

The new No. 40 Circle Template for designers, draftsmen, and engineers is now available from **Rapidesign, Inc.**, P.O. Box 592, Glendale, Calif.

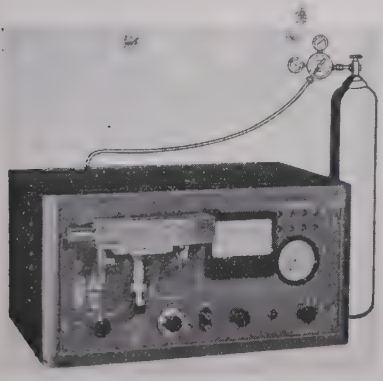
This template has thirty-nine circles grouped in progressive sizes with increments in 64ths, 32nds, 16ths, and 8ths of an inch.

Whole numbers are used for quick reference to the various sizes.

The No. 40 is made of 0.030″ matte-finish cellulose-nitrate sheet, precision milled with allowance for pencil point to insure accuracy. Each circle is marked and has a center guide line. Actual size is $4'' \times 7\frac{1}{4}''$.

Alpha Proportional Counter

The Model 117 Alpha Proportional Counter System, developed by **Instrument Development Laboratories, Inc.**, 223–233 W. Erie St., Chicago 10, Ill., was designed for counting alpha particles in the presence of a strong beta activity.



The methane-flow proportional-counter chamber with sample holder has a highly polished cylindrical cathode. The anode is 0.002″ tungsten wire mounted between glass insulators.

The two-tube high-gain linear amplifier has a flat frequency response between 10,000 cps and 2 megacycles and has variable gain. The gain is controlled by a panel dial which can be set so that pulses from the counter exceeding any desired amplitude between 2 millivolts and 20 millivolts

(Continued on page 62A)

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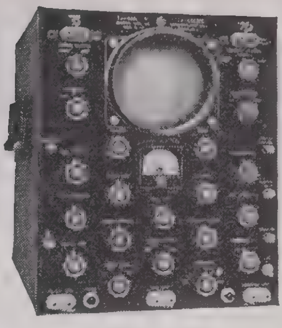
OSCILLOSYNCHROSCOPE
Model OL-15B

Designed for maximum usefulness in laboratories doing a variety of research work, this instrument is suited to radar, television, communication, facsimile, and applications involving extremely short pulses or transients. It provides a variety of time bases, triggers, phasing and delay circuits, and extended-range amplifiers in combination with all standard oscilloscope functions.



THESE FEATURES ARE IMPORTANT TO YOU

- Extended-range amplifiers: vertical, flat within 3 db 5 cycles to 6 megacycles; horizontal, flat within 1 db 5 cycles to 1 megacycle.
- High sensitivity: vertical, 0.05 RMS volts per inch; horizontal 0.1 RMS volts per inch.
- Single-sweep triggered time base permits observation of transients or irregularly recurring phenomena.
- Variable delay circuit usable with external or internal trigger or separate from 'scope.
- Sawtooth sweep range covers 5 cycles to 500 kilocycles per second.
- 4,000 volt acceleration gives superior intensity and definition.

For complete data, request Bulletin 4810-RO

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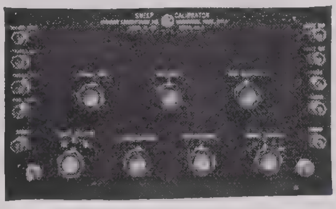

Model GL-22

This versatile source of timing markers provides these requisites for accurate time and frequency measurements with an oscilloscope:

- Positive and negative markers at 0.1, 0.5, 1.0, 10, and 100 microseconds.
- Marker amplitude variable to 50 volts.
- Gate having variable width and amplitude for blanking or timing.
- Trigger generator with positive and negative outputs.

Further details are given in Bulletin 4810-RC.

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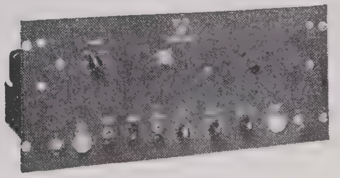

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Here is the heart of a super high frequency signal generator with square wave, FM, or pulse modulation. Provides for grid pulse modulation to 60 volts, reflector pulse modulation to 100 volts, square wave modulation from 600 to 2,500 cycles. Voltage-regulated power supply continuously variable 280-480 or 180—300 volts dc. For additional data and application notes, see Bulletin 4810-RM.

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Write for Bulletin 4810-RA containing full details of this useful instrument.

- Standing wave voltage ratios are read directly on the panel meter of this sensitive, accurate measuring instrument.
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- Two input channels with separate gain control for each.
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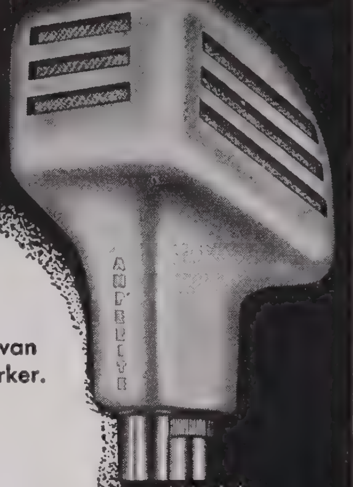

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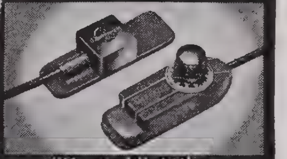

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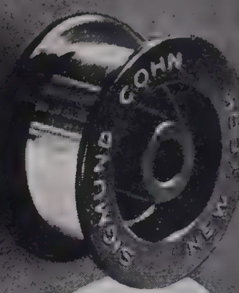

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54 to 216 MEGACYCLES

The model 202-B is specifically designed to meet the needs of television and FM engineers working in the frequency range from 54-216 mc. Following are some of the outstanding features of this instrument:

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VERNIER DIAL—24:1 gear ratio with main frequency dial.

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This book clearly presents the principles of electro-magnetic theory and their practical applications to engineering practice. The author has placed particular emphasis on the basic ideas of Maxwell's equations, and has included many examples to demonstrate them. The rationalized mks system of units has been introduced throughout the book, and explanatory notes in the early chapters clarify this system for those used to the cgs system.

Completely up to date

Much new material has been included in this second edition. The latest information on cylindrical and rectangular wave guides has been incorporated, and there has been an increase and reorganization of the data on the reflection of waves and on antennas. The discussion on wave transmission through semi-conducting media and in ionized regions has been explained.

Contents include:

Experiments on the Electrostatic Field; Vector Analysis; Certain Theorems Relating to Fields; The Electrostatic Field; Electric Current; The Magnetic Field; Examples and Interpretation; Maxwell's Hypothesis; Plane Waves; Reflection; Radiation; Antennas; Wave Guides; Waves in the Ionosphere.

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STABILIZED CRYSTALS TO MEET EVERY NEED

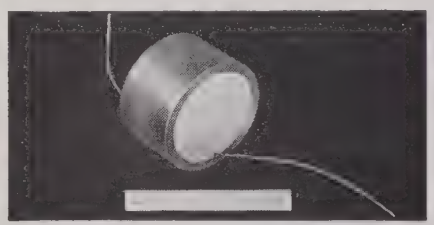
Whatever your crystal needs, James Knights Co. is equipped to satisfy them quickly and economically.

To effect greater savings for you on short runs, a special production system has been established.

We are also equipped to quickly build "Stabilized" crystals to your exact specifications. In addition, James Knights Co. fabricates a complete line of "Stabilized" crystals to meet every ordinary need—precision built by the most modern methods and equipment.

For quality—speed—economy, contact the James Knights Co. You'll be glad you did!

New James Knights Catalog On Request



A university physicist wanted a 2" supersonic X-cut crystal. The James Knights Co. made it promptly and has since delivered many other special crystals for the same university.

The JAMES KNIGHTS Co.

SANDWICH, ILLINOIS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

will trip the scaler. This allows discrimination between the pulses caused by beta particles and those of an alpha particle.

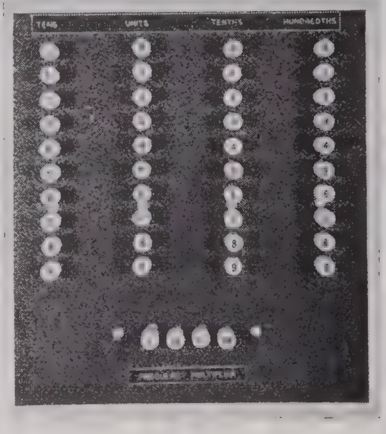
The scaling circuit is of the binary type a Higinbotham scaler with a selecting switch permitting selection of scales 8, 64, 128, and 256.

The impulse-recording unit is actuated by a driving tube driven by the last scaling stage. Utilizing the scale 256 it is fast enough to register a rate of 500,000 counts per minute.

The counter has a built-in stabilized variable voltage supply. A meter shows the counter anode voltage reading from 1500 to 3000 volts.

Burnell's Keyboard Oscillator

A resistance-tuned type of oscillator using a negative feedback, described as "Burnell's Keyboard Oscillator," Model 150-AO-1/100.000, is being manufactured (in agreement with Burnell & Co., 45 Warburton Ave., Yonkers 2, N. Y.) by **Weinschel Engineering Co.**, Dept. 1, 123 William St., New York 7, N. Y., under a license from Western Electric Co.



The manufacturer claims that the use of aged, low-temperature-coefficient components produces high stability as to frequency.

The frequency may be varied in steps of 0.01 cps for the range of 1 to 100 cps, 0.1 for 100 to 1000 cps, 1.0 for 1 kc to 10 kc, 10.0 cps for 10 kc to 100 kc.

A continuous fine control in the range of 10 to 100 kc permits adjustment to 1 cps, so that a stationary pattern may be obtained on a comparison oscilloscope when calibrating the oscillator against a frequency standard.

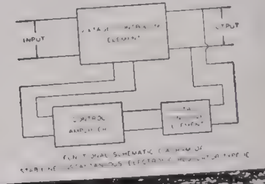
The specifications are: range, 1 to 100,000 cps; stability, drift less than 0.02% per hour after 15 minutes warmup; power supply, 105 to 125 volts, 50 to 60 cps ac, 50 watts; output impedance, 150 ohms internal generator impedance, one side grounded; maximum no load voltage, 15 volts; distortion in the range 20 to 20,000 cps, less than 0.3% if the load is greater than 1,000 ohms.

Problem:

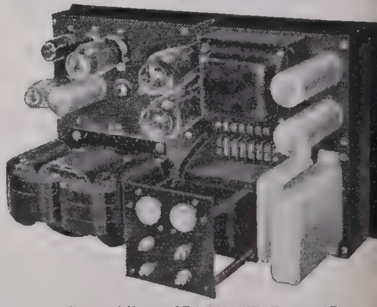
To hold "Nominal Voltages" to within ±0.1 volts.........

Solution:

Use STABILINE IE



Your utility company may quote a nominal voltage — but power suppliers are allowed to vary, within certain limits, from the nominal. This condition, plus load changes in your own operation, results in voltages other than nominal. A STABILINE Automatic Voltage Regulator Type IE in your power line assures you of constant voltage. It's *instantaneous* in action — completely *electronic* in operation. Holds delivered voltages to within ±0.1 volts, regardless of line variation . . . within ±0.15 volts for any load current change or load power factor change from lagging .5 to leading .9. Maximum waveform distortion never exceeds 3 percent.



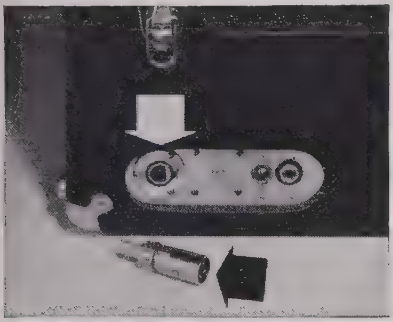
Rear View STABILINE Type IE

Bulletin 547 gives you information on this and other Superior Electric voltage control equipment. Write for your copy today.

THE
SUPERIOR ELECTRIC
COMPANY
810 Meadow Street
BRISTOL, CONN.

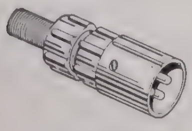
Model BK-403 Brush Magnetic Ribbon Recorder

BRUSH SOUNDMIRROR USES "XL"

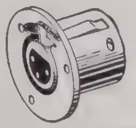


Arrows point to XL Plug and Receptacle

AMONG the many new developments in the electronics field is the *"Soundmirror"* which uses Cannon Electric XL connectors.



XL-3-12 Plug



XL-3-13 Receptacle

High on the list of features which make Cannon Electric's "XL" series desirable for quality equipment is the latchlock device which assures quick, positive engagement but also will not pull out accidentally.

For more information on the XL Type Series, write for the XL-347 Bulletin and special condensed catalog RJC-2. Address Department J-377.

SINCE 1915

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Development Company

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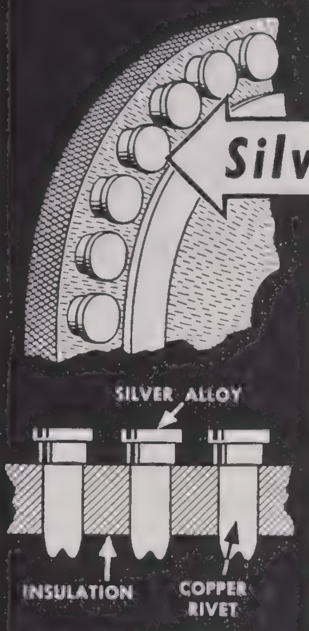
Silver Alloy Contacts



New Silver Alloy contacts make possible improved Attenuators and Switches in smaller sizes.

1 Greater Creapage Distance—thus better insulation.
2 No silver migration.
3 Greater silver surface to carry current.
4 Lower contact resistance.
5 Better mechanical operation of switch.
6 Less capacity between contacts—better frequency characteristics.
7 Better clearance to ground.

TYPE 800 UNIT
with new contacts

TECH LABORATORIES, INC.

Manufacturers of Precision Electrical Resistance Instruments

Bergen and Edsall Blvds. • Palisades Park, N.J.

Measure Frequencies

- ***INSTANTLY*** . . . direct reading. No computation.
- ***ACCURATELY*** . . . to a frequency determination of 0.05%.
- ***VISUALLY*** . . . at the turn of the dial indicator knob.

Used effectively in leading laboratories, such as: Harvard University, Bell Aircraft Corp., and Hamilton Standard Propellers . . . for measuring natural frequencies or speed of rotating objects, checking or calibrating tachometers, oscillators, impulse generators, similar equipment.

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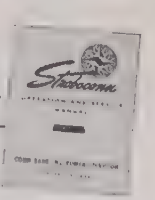

Please send *free* Strobocomn folder containing information about operation and application of this new precision instrument. I understand this places me under no obligation.

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INFORMATION SERVICE

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A two-fold service is available without cost to firms supplying products for or rendering technical services to the radio-and-electronic industry. (1) The I.R.E. Yearbook, which is noted for its reference value, lists more than 2,000 firms and furnishes product or industry classification. (2) A classified index of products and services is maintained by the I.R.E. Industry Research Division. Radio engineers continuously draw upon this bank of statistical data.

These two sources of information are not only invaluable to I.R.E. members and other engineers, but the proper listing of your company may bring you new business.

To help keep up to date, please check-off your products and services. These may be rewritten on the coupon on next page and sent to: Industry Research Div., Proceedings of the I.R.E. Room 707, 303 West 42nd St., New York 18, N.Y.

Products to Be Checked By Radio-Electronic Manufacturers

- **1. AMPLIFIERS, Audio Frequency.**
    - ( ) a. Broadcast Speech Input Equipment.
    - ( ) b. Dynamic Noise Suppressors.
    - ( ) c. High Fidelity.
    - ( ) d. Inter-communication Systems.
    - ( ) e. Medical Equipment.
    - ( ) f. Peak Limiting.
    - ( ) g. Phonograph Preamplifiers-equalized.
    - ( ) h. Power Amplifiers.
    - ( ) i. Pre-amplifiers.
    - ( ) j. Public Address Systems.
    - ( ) k. Recording Amplifiers.
- **2. ANTENNAS.**
    - ( ) a. AM Broadcast.
    - ( ) b. Dummy.
    - ( ) c. FM Broadcast.
    - ( ) d. Miscellaneous.
    - ( ) e. Receiving Types, all services.
    - ( ) f. Television Broadcast.
- **3. ANTENNA ACCESSORIES.**
    - ( ) a. Feeder Systems.
    - ( ) b. Insulators.
    - ( ) c. Phasing & Tuning Equipment.
    - ( ) d. Support Towers.
    - ( ) e. Tower Lighting Equipment.
- **4. ATTENUATORS.**
    - ( ) a. Audio Frequency.
    - ( ) b. Radio Frequency.
- **5. BATTERIES.**
    - ( ) a. Flashlight & Miscellaneous Dry.
    - ( ) b. Hearing Aid.
    - ( ) c. Portable Radio Types.
    - ( ) d. Storage.
- **6. BLOWERS & COOLING FANS.**
    - ***Bridges, see 60a.***
- **7. CABLE & WIRE.**
    - ( ) a. Co-axial Cable.
    - ( ) b. Pre-formed Harnesses
    - ( ) c. Rubber Insulated Wires.
    - ( ) d. Shielded Types.
    - ( ) e. Synthetic Insulated Wires.
    - ( ) f. U.H.F. Types.
- **8. CAPACITORS: Fixed.**
    - ( ) a. Ceramic.
    - ( ) b. Electrolytic.
    - ( ) c. Mica.
    - ( ) d. Oil Filled.
    - ( ) e. Paper.
    - ( ) f. Pressurized Gas.
    - ( ) g. Vacuum.
- **9. CAPACITORS: Variable.**
    - ( ) a. Neutralizing.
    - ( ) b. Precision.
    - ( ) c. Temperature Frequency Compensating.
    - ( ) d. Trimmers.
    - ( ) e. Tuning.
    - ( ) f. Vacuum.
- **10. CERAMICS.**
    - ( ) a. Coil Forms.
    - ( ) b. Custom Fabrication.
    - ( ) c. Rods.
    - ( ) d. Sheets.
- **11. CHASSIS & RELAY RACK CABINETS: Metal.**
    - ( ) a. Open Stock.
    - ( ) b. Special Order & Custom Fabrication.
    - ***Coil Forms, see 10a.***
- **12. COILS.**
    - ( ) a. A. F. Chokes.
    - ( ) b. Miscellaneous.
    - ( ) c. R. F. Chokes.
    - ( ) d. Toroids.
    - ( ) e. Transformer Coils.
    - ( ) f. Tuning.
    - ***Condensers, see 8 & 9.***
- **13. CONNECTORS.**
    - ( ) a. AN Standard Types.
    - ( ) b. Microphon.
    - ( ) c. Power.
    - ***Consoles, see 1a.***
- **14. CONVERTERS.**
    - ( ) a. Frequency.
    - ( ) b. Vibrator.
    - ***Rotary, see 38.***
- **15. CORES & CORE MATERIALS.**
    - ( ) a. Complete Cores.
    - ( ) b. Laminations.
    - ( ) c. Powdered Metal.
- **16. CRYSTALS.**
    - ( ) a. Germanium & Silicon, etc.
    - ( ) b. Oscillating Quartz.
    - ( ) c. Piezo-Electric.
- **17. CRYSTAL HOLDERS.**
    - ***Discs, Recording, see 51a.***
- **18. DRAFTING EQUIPMENT & SUPPLIES.**
    - ***Dynamotors, see 38a.***
- **19. ELECTRONIC CONTROL EQUIPMENT.**
    - ( ) a. Air Conditioning Controls.
    - ( ) b. Burglar Alarm & Protection Devices.
    - ( ) c. Combustion & Smoke Elimination.
    - ( ) d. Fire Prevention & Detection.
    - ( ) e. Production Controls, Counting & Sorting.
    - ( ) f. Variable Speed Regulators.
    - ( ) g. Voltage Control & Stabilization.
- **20. EQUALIZERS.**
    - ( ) a. Dialogue.
    - ( ) b. Line.
    - ( ) c. Magnetic Reproducer Types.
    - ( ) d. Sound Effects.
- **21. FACSIMILE EQUIPMENT.**
- **22. FILTERS.**
    - ( ) a. Band Pass & Band Rejection.
    - ( ) b. Dividing Networks.
    - ( ) c. Noise Elimination.
    - ***Sound effects, see 20d.***
    - ***Frequency Measuring Equipment, see 37a, 59a, 61b, c, d, and e***
- **23. FUSES & FUSE HOLDERS.**
    - ***Generators, see 38c.***
- **24. GRAPHIC RECORDERS.**
- **25. HARDWARE & MANUFACTURING AIDS.**
- **26. INDUCTION HEATING EQUIPMENT.**
    - ( ) a. Manufacturing Processes.
    - ( ) b. Medical Applications.
    - ***Inductors, see 12.***
- **27. INSULATION.**
    - ( ) a. Cloth.
    - ( ) b. Glass.
    - ( ) c. Mica.
    - ( ) d. Paper.
    - ( ) e. Varnished Cambric.
    - ***See also 10 & 45.***
- **28. JACKS, JACK FIELDS, PLUGS, & PATCH CORDS.**
- **29. KEYS.**
    - ( ) a. Switching.
    - ( ) b. Telegraph.
    - ***Knobs, see 40c.***
- **30. LACQUERS.**
    - ( ) a. Finishing.
    - ( ) b. Fungus Proofin
    - ( ) c. Moisture Proof
- **31. LOUDSPEAKERS & H PHONES.**
    - ( ) a. Commercial G Loudspeakers
    - ( ) b. Headphones.
    - ( ) c. High Fidelity speaking Sys
    - ( ) d. High Frequenc Types.
    - ( ) e. Low Frequency Types.
- **32. MACHINERY, FIXTU & TOOLS FOR RA ELECTRONIC MANU FACTURING.**
- **33. MAGNETS.**
    - ( ) a. Electro.
    - ( ) b. Permanent.
    - ***Measuring Equipment, 35, 59, 60, 61.***
- **34. METALS: Base.**
    - ( ) a. Copper.
    - ( ) b. Ferrous.
    - ( ) c. Non-ferrous, e ing Copper.
    - ( ) d. Powdered.
    - ( ) e. Precious & Ra
- **35. METERS.**
    - ( ) a. Ammeters.
    - ( ) b. Elapsed Time.
    - ( ) c. Frequency Indi ing.
    - ( ) d. Voltmeters.
    - ( ) e. Volume Level (dB & VU).
    - ( ) f. Wattmeters & Hour Meters.
    - ***Vacuum Tub Voltmeters, s 60i.***
- **36. MICROPHONES.**
    - ( ) a. Carbon.
    - ( ) b. Condenser.
    - ( ) c. Crystal.
    - ( ) d. Magnetic.
- **37. MONITORING EQUIPMENT.**
    - ( ) a. Frequency.
    - ( ) b. Modulation.
- **38. MOTOR GENERATOR**
    - ( ) a. Dynamotors.
    - ( ) b. Frequency Changers.
    - ( ) c. Motor-Generato
    - ( ) d. Rotary Convert

MOTORS: Very Small.
( ) a. Blower Motors.
( ) b. Selsyn Controls.
( ) c. Timing Devices.

MOULDED PRODUCTS & SERVICES.
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( ) b. Insulators.
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( ) d. Proprietary Mouldings.
( ) e. Special Fabrication.

OPTICAL SYSTEMS, MIRRORS, SCREENS, & ACCESSORIES.
***Oscillators*, see 59a, d & 61b, c, d, e.**

OSCILLOGRAPHS & ACCESSORIES.
( ) a. General Purpose, Cathode Ray.
( ) b. Recording.
( ) c. Synchroscopes, Cathode Ray.
( ) d. U.H.F. Cathode Ray Equipment.
***Panels*, see 11.**

PHONOGRAPH & TRANSCRIPTION REPRODUCING EQUIPMENT.
( ) a. Crystal Pick-ups.
( ) b. Magnetic Pick-ups.
( ) c. Phonograph Motors.
( ) d. Playback arms.
( ) e. Record Changers.
( ) f. Turntables, complete.
***Pre-amplifiers*, see 1i.**

PILOT LIGHTS & ASSEMBLIES.
( ) a. Incandescent.
( ) b. Neon.

PLASTICS.
( ) a. Raw Powders for Moulding.
( ) b. Rods.
( ) c. Sheets.
***Plugs*, see 13 & 28.**

POINT TO POINT COMMUNICATION EQUIPMENT.
( ) a. Aircraft & Airport Equipment.
( ) b. Citizen Radio.
( ) c. Emergency Communications.
( ) d. Fleet Dispatching.
( ) e. Police & Fire Department Equipment.
( ) f. Ship to Shore Equipment.

POWER SUPPLIES.
( ) a. Electrically Powered.
( ) b. Gasoline Driven.
( ) c. Voltage Regulated Output types.
***Printed circuits*, see 25.**

PUMPS: Vacuum.
***Racks*, see 11.**
***Radar Equipment*, see 64b.**

49. RADIO RECEIVERS
( ) a. Broadcast.
( ) b. Communications.
( ) c. Fixed Frequency.
( ) d. Frequency Modulation.
( ) e. Special Purpose.
( ) f. Television.

50. RECORDING EQUIPMENT.
( ) a. Disc Recording Machines.
( ) b. Magnetic Tape Recorders.
( ) c. Magnetic Wire Recorders.

51. RECORDING ACCESSORIES & SUPPLIES.
( ) a. Blanks.
( ) b. Cutting Needles.
( ) c. Disc Recording Heads.
( ) d. Magnetic Recording Playback, & Biasing Heads.
( ) e. Magnetic Recording, Tape.
( ) f. Magnetic Recording Wire.

52. RECTIFIERS.
( ) a. Metallic.
( ) b. Vacuum Tube.
***Regulators, Voltage*, see 67.**

53. RELAYS.
( ) a. Hermetically sealed.
( ) b. Instrument.
( ) c. Keying.
( ) d. Mercury.
( ) e. Power Control & Overload.
( ) f. Stepping.
( ) g. Telephone Types.
( ) h. Time Delay.

54. REMOTE CONTROLLING EQUIPMENT.
( ) a. Automatic Tuning Mechanisms.
( ) b. Remote Controls.
( ) c. Switching Functions.
( ) d. Servo-Mechanisms.

55. RESISTORS.
( ) a. Carbon fixed.
( ) b. Carbon Variable.
( ) c. Precision.
( ) d. Vacuum Sealed.
( ) e. Wire Wound, Fixed.
( ) f. Wire Wound, Variable.

56. SOCKETS, VACCUM TUBE.
( ) a. Receiving Tube Types.
( ) b. Transmitting Tube Types
( ) c. Underwriters Laboratories Approved Types.

57. SOLDER.
( ) a. Acid Cored.
( ) b. Plain.
( ) c. Precious Metal.
( ) d. Pre-forms.
( ) e. Rosin Cored.
***Speakers*, see 31.**

58. SWITCHES.
( ) a. Band Switches.
( ) b. Circuit Breaking.
( ) c. Key.
( ) d. Mercury Switches.
( ) e. Momentary Contact.
( ) f. Power.
( ) g. Precision Snap-Acting.
( ) h. Rotary
( ) i. Time Delay.
( ) j. Toggle & Push Button.

59. TESTING & MEASURING EQUIPMENT: Audio Frequency.
( ) a. Beat Frequency Oscillators.
( ) b. Distortion & Noise Analyzers.
( ) c. Intermodulation Distortion Analyzers.
( ) d. Resistance Capacity Oscillators.
( ) e. Square Wave Generators.
( ) f. Wave Form Analysis Equipment.

60. TESTING & MEASURING EQUIPMENT: General.
( ) a. Bridges, all types.
( ) b. Capacitance Decades
( ) c. Capacitor Testers.
( ) d. Multi-meters.
( ) e. Resistance Decades.
( ) f. Resistor Testers-Ohmmeters.
( ) g. Stroboscopes.
( ) h. Tube Testers.
( ) i. Vacuum Tube Voltmeters.
( ) j. Vibration Testing Equipment.

61. TESTING & MEASURING EQUIPMENT: Radio Frequency.
( ) a. "Q" Meters.
( ) b. Signal Generators, AM.
( ) c. Signal Generators, FM.
( ) d. Signal Generators, TV.
( ) e. Standard Frequency Generators & Multi-Vibrators.
( ) f. Sweep Generators & Calibrators.
( ) g. Wavemeters.

62. TRANSFORMERS.
( ) a. Audio Frequency.
( ) b. Hermetically Sealed.
( ) c. High Fidelity Audio Types.
( ) d. Power Components.
( ) e. Pulse Generating Types.
( ) f. Radio Frequency.
( ) g. Voltage Regulating.

63. TRANSMITTERS.
( ) a. AM Broadcast.
( ) b. Communications.
( ) c. FM Broadcast.
( ) d. Special Types.
( ) e. TV Broadcast.

64. ULTRA HIGH FREQUENCY EQUIPMENT & ACCESSORIES.
( ) a. Antennas & Reflectors.
( ) b. Radar Apparatus.
( ) c. Receivers.
( ) d. Transmitters.
( ) e. Waveguides.

65. VACUUM TUBES.
( ) a. Cathode Ray.
( ) b. Geiger-Mueller.
( ) c. Industrial types.
( ) d. Klystrons & Magnatrons.
( ) e. Phototubes.
( ) f. Pirani Tubes.
( ) g. Receiving Types.
( ) h. Rectifiers.
( ) i. Special Purpose.
( ) j. Thyratrons.
( ) k. Television Types.
( ) l. Transmitting Types.
( ) m. Voltage Regulators.

66. VACUUM TUBE COMPONENT PARTS.
***Varnishes*, see 30.**

67. VOLTAGE REGULATORS.
( ) a. Automatic.
( ) b. Manually Controlled.

68. WAXES, POTTING & SEALING COMPOUNDS.

69. WOODEN CABINETS.
( ) a. Radio Sets.
( ) b. Record Storage.

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93. CONSULTING ENGINEERS.
( ) a. Acoustical.
( ) b. Electrical.
( ) c. Mechanical.
( ) d. Radio.

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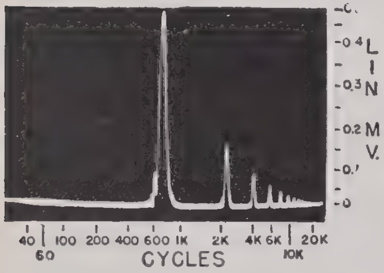
AUDIO ANALYSIS

with Model AP-1

PANORAMIC SONIC ANALYZER

Reduce time, complexity and cost of making audio measurements with the unusual advantages offered by the Panoramic Sonic Analyzer. By resolving a complex audio wave into a spectrograph showing the frequency distribution and voltage amplitude of the components, Model AP-1 . . .

• Eliminates slow point-by-point frequency checks • Provides a quick overall view of the audio spectrum • Enables determination of changes in waveform content while parameters are varied • Furnishes simple presentations for production line testing.



Panoramic Sonic Spectrograph of 750 cps square wave.

Use Model AP-1 for analyzing . . .
• Harmonics • Intermodulation • Vibration • Noise • Acoustics • Materials

Features . . . Continuous scanning from 40-20,000 cps in one second • Wide input voltage range • Linear and log voltage scale • Closely logarithmic frequency scale • Built-in voltage and frequency calibrator • Simple operation.

WRITE for detailed specs, price and delivery.

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Bead Chain Mfg. Co. .... YB
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Electrical Reactance Corp. .... YB 7A
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Electro-Tech Equipment Co. .... YB
Electro-Voice, Inc. 40A
Engineering Research Associates, Inc. 50A
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Federal Telecommunication Laboratories 50A
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Ferranti Electric, Inc. .... YB
Field Electrical Inst. Co. .... YB
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Kollsman Instrument Division .... YB

(Continued on page 67A)

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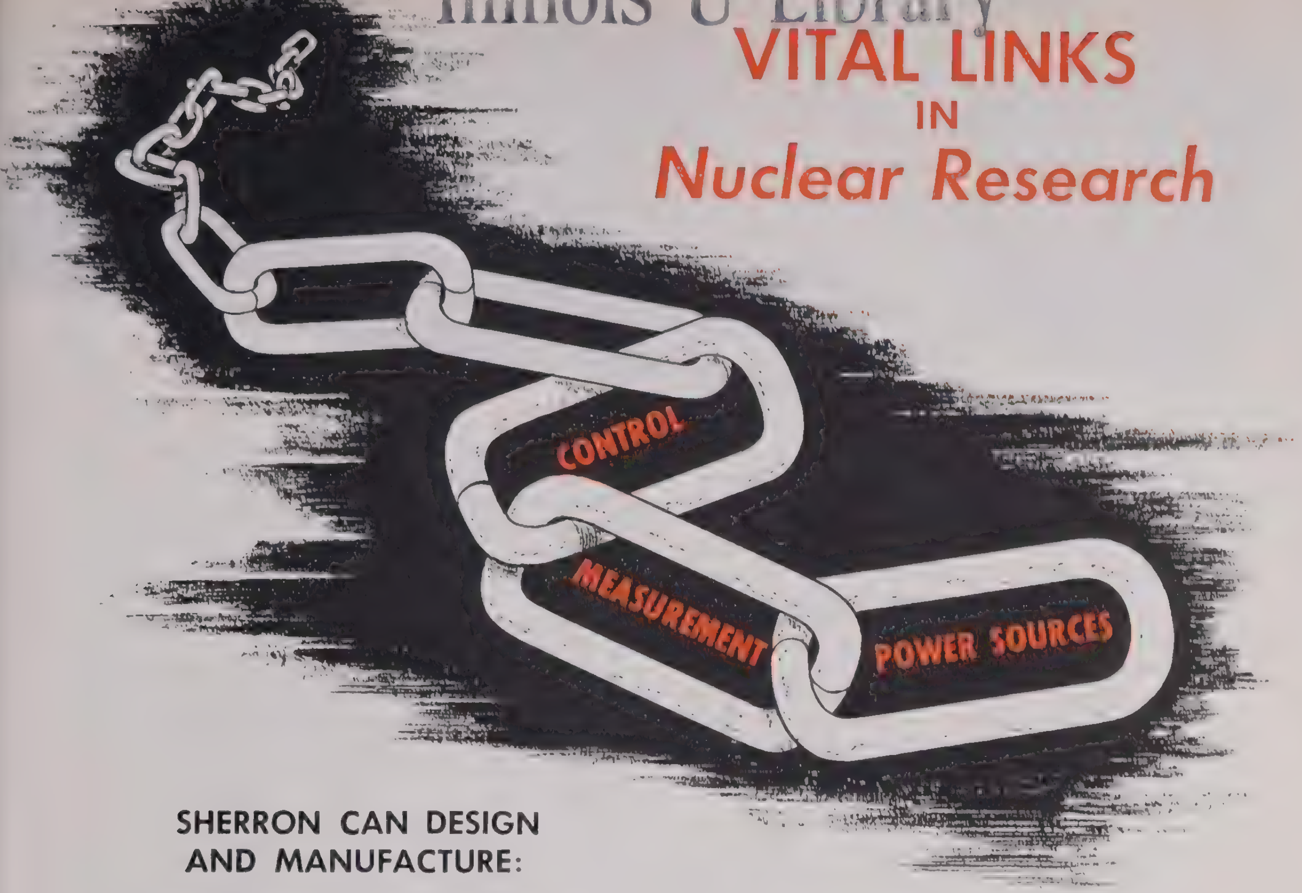

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Table of contents will be found following page 32A

The 1304 is *TOPS!*

TOPS in
Reproduction quality—operating convenience

REPRODUCTION QUALITY? The Western Electric 1304 Set combines the 109 Type Reproducer Group with its extremely low intermodulation distortion and a unique new driving mechanism (shown in Fig. 1) that cuts flutter to a value lower than many standard recording equipments.

Even the small amount of flutter originating in the mechanism's simple gearing is damped in the novel filter of Fig. 2. Result: a flutter level, *including wow,* of less than 1/10 of 1% *at both 78 and 33-1/3 rpm.*

The platter has been isolated from the sources of rumble by means of the drive isolation coupling (Fig. 4), the fabric belt, and by mounting the entire drive mechanism on rubber vibration mounts (Fig. 3). The large drive pulleys, the use of large belt wrap around, and an adjustable spring loaded idler pulley prevent belt slippage problems.

OPERATING CONVENIENCE? Speed change-over at the throw of a switch. Acceleration to 33-1/3 rpm in *1/9 revolution*—to 78 rpm in *less than 1/2 revolution.* Rapid slowdown — no overdrive — convenient flange on platter for quick stopping.

And playing time variation is *less than ± 2 seconds in 15 minutes!*

Scientific placement of elements facilitates operation. An annular groove in the platter makes it easy to grasp edge of 10- or 12-inch records. 706A Guard provides automatic arm rest, keeps stylus from dropping on panel, catching in turntable felt, or striking edge of revolving platter.

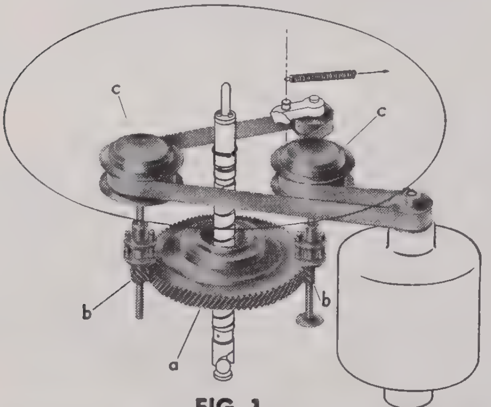

FIG. 1

A single helical ring gear (a), is permanently meshed with two pinion gears (b), each driven by an overriding clutch (c). Reversing direction of motor rotation disengages one overriding clutch, engages the other to change platter speed. Permanently meshed gears eliminate possibility of flutter caused by wear of engaging and disengaging.

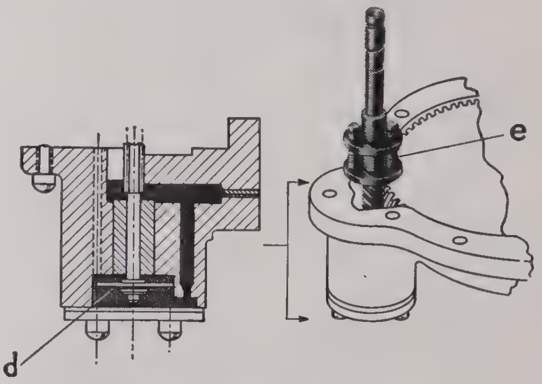

FIG. 2

As shown in cut-away view, a coupling (e) allows each pinion and associated shaft to move a short distance along its axis. The bottom of each pinion shaft projects into an oil-filled chamber (d) for damping axial motion. Because of the helical gearing and the high inertia of the turntable platter, irregularities in the drive tending to cause flutter are taken up and damped in axial motion of the driving pinion.

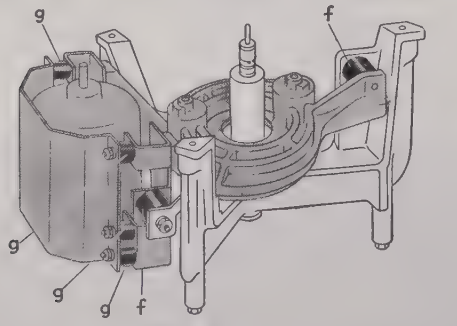

FIG. 3

The entire mechanism, including motor, floats separately from frame and platter shaft on three large rubber mountings (f). Motor, in turn, is isolated from the gear system by smaller rubber mountings (g) and the use of belt drive.

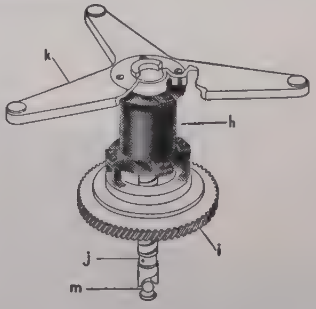

FIG. 4

Drive isolation coupling (h), provides the only connection between driving gear (i), platter shaft (j) and platter support (k), completing the separation of drive mechanism from platter. This coupling—very rigid in rotational plane, highly flexible in all others—transmits the driving motion, but isolates the rumble-causing motion. Platter and support ride on a hardened single ball thrust bearing (m).

TOPS in flexibility of installation

THE WESTERN ELECTRIC 1304 Type Reproducer Set is a single compact unit, readily adaptable to a wide range of installation requirements. It is available in a variety of cabinet arrangements to permit the greatest possible flexibility in installation.

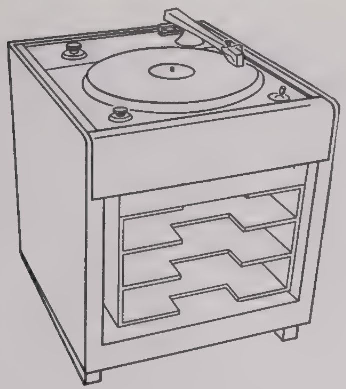

FIG. 5

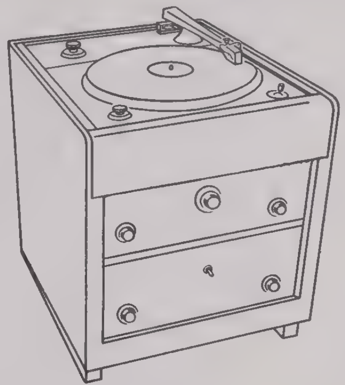

FIG. 6

The 1304 Reproducer Set. includes a floor type cabinet with or without a removable door. The 701A Shelf is available which provides record storage space (Fig. 5), or the cabinet may be arranged for mounting standard amplifying equipment (Fig. 6). In either case, additional space for equipment is available at the rear of the cabinet.

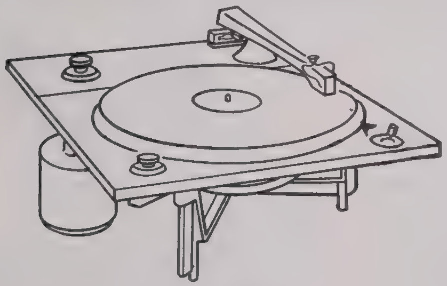

FIG. 7

If you want the superb reproduction and the operating convenience of the 1304—but prefer to use an existing table or a specially built cabinet—just specify the 304 Type Reproducer Panel. This is a complete panel unit, all ready to install, with exactly the same drive mechanism used in the 1304. The 109 Group with 706A Guard, on-off and speed-change switches and platter are all included.

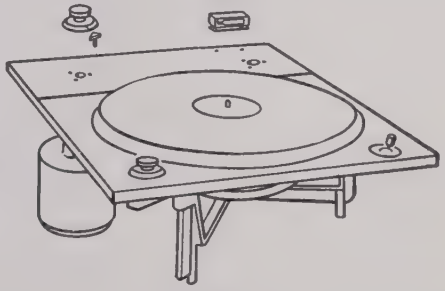

FIG. 8

You can also use the drive mechanism of the 1304 with your own reproducer group. The 305A Panel is drilled to take the 109 Type Group, and is furnished with 706A Guard, equalizer knob and the required hardware for mounting the 109 Type Group. The 305B Panel can be drilled in the field to mount reproducer groups other than the 109. (706A Guard and equalizer knob not included.)

For complete information on the 1304 Reproducer or Reproducer Group—or on the 304, 305A or 305B Panels—call your nearest Graybar Broadcast Representative. Or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

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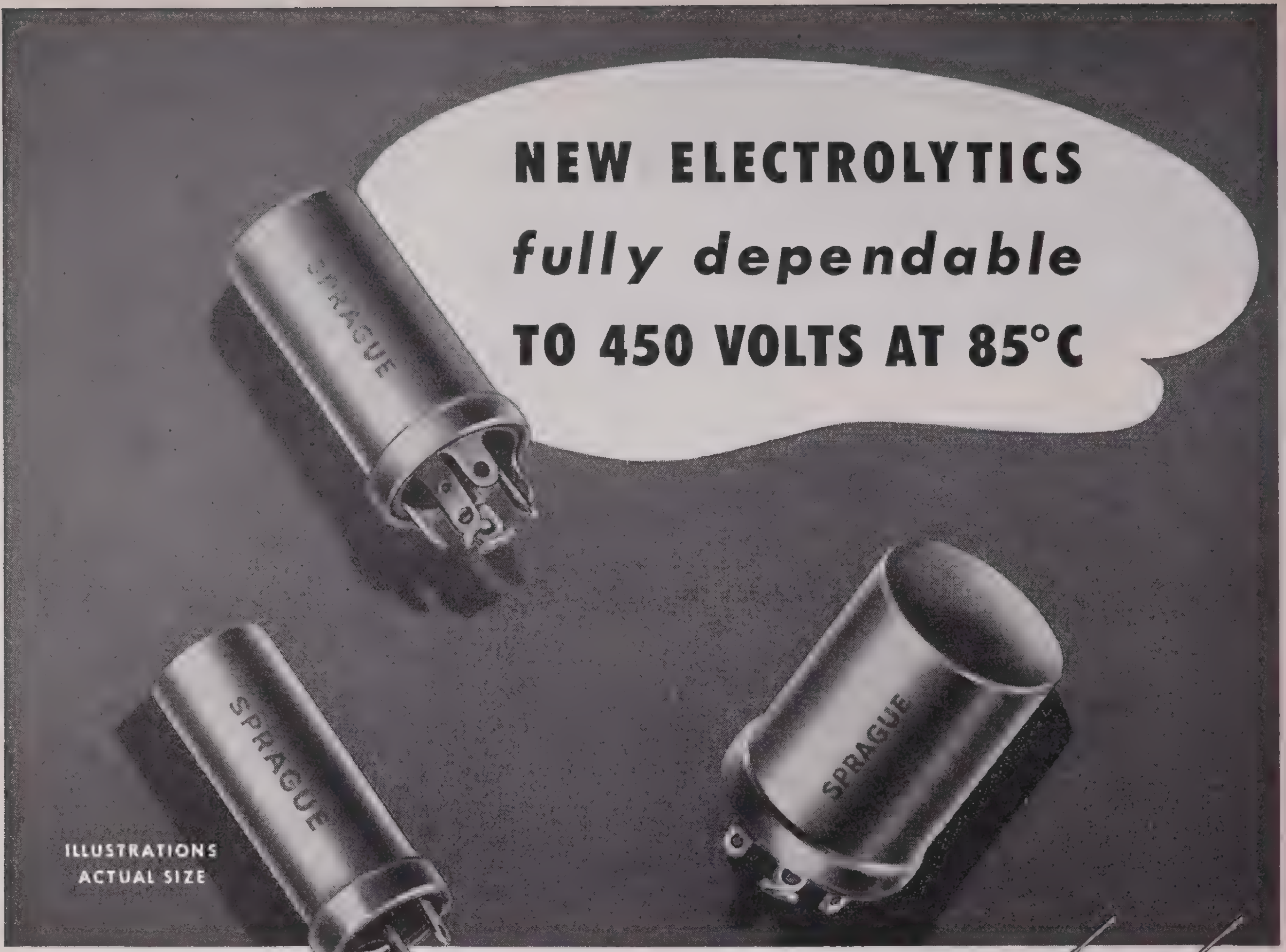
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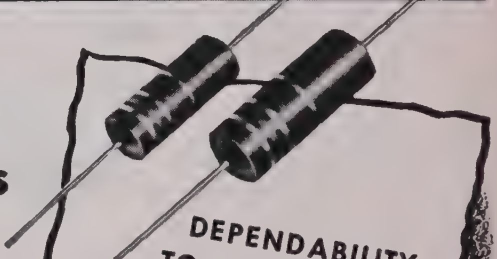

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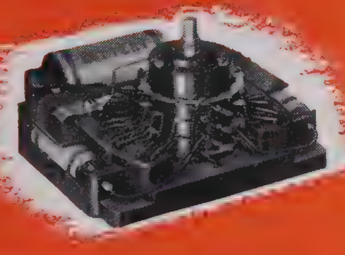
with cover over resistor pockets removed to show design

The ruggedness, the simplicity of design, and the consequent accessibility of components are shown here. Molded of sturdiest bakelite, the sub-panel provides separate pockets for resistors. This separation makes for orderly assembly, highest possible accessibility, and added insulation for preventing shorts. All connections are short and direct. Cable wiring is eliminated. Each battery has its own compartment, again increasing accessibility.



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News—New Products

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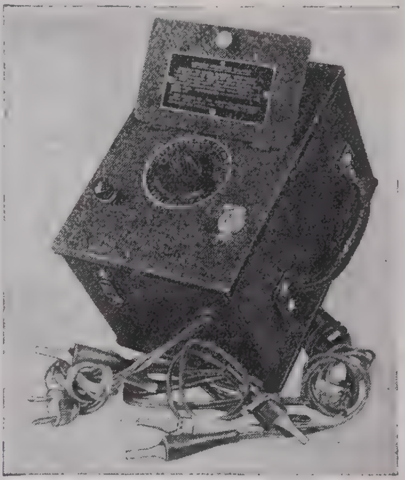
A Filter Selector Unit

What interference filter to use and how to connect it may be readily and positively determined by the Aerovox Interference Filter offered by Aerovox Corp., New Bedford, Mass.



The "Selector" is portable, housed in a metal cabinet with a slide handle and hinged-cover compartment holding the assortment of connecting cords, plugs, receptacles and clips, which are readily connected in various ways with the noise-producing appliance or equipment. The knob is then turned through the series of different settings, each bringing into circuit the same circuit elements as found in Aerovox interference filters of corresponding type numbers. Thus the type of filter to use, as well as the appropriate connections, are immediately known, and the permanent installation can be made accordingly.

Recent Catalogs

• • • Bulletin E-133 explains Hytron 3B4, a vhf beam pentode power amplifier, from **Hytron Radio & Electronics Corp.,** 76 Lafayette St., Salem, Mass.

• • • A folder describing the Compa-Station, a complete compact 2 way radio communication system, by **Motorola, Inc.,** 4545 Augusta Blvd., Chicago 5, Ill.

• • • On type 1684 D, Furzehill direct coupled cathode ray oscilloscope, from **American British Technology, Inc.,** 57 Park Ave., New York 16, N. Y.

• • • A brochure with detailed information about Models P54 and P55 pulse generators, by **Raymond M. Wilmotte, Inc.,** 1469 Church St., N. W., Washington 5, D. C.

• • • A bulletin on "W" waterproof connectors has been reprinted, revised, and enlarged to include typical insert arrangements and tabular data "AN" layouts in shell sizes Nos. 16, 22, and 36 adaptable to "W" shells, by **Cannon Electric Development Co.,** 3209 Humbolt St., Los Angeles 31, Calif.

(Continued on page 40A)

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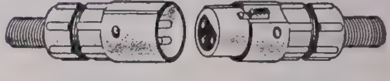

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For catalog information, write for XL-347 Bulletin, and the RJC-2 Special Condensed Catalog with list prices. Address Department K-377.

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"Radar—Its Applications to Marine Service," by A. H. Cassiet, Argentine Navy; July 23, 1948.

"Television—Considerations on Transmitters—Agreements of Latest Television Congresses," by R. Barthélemy, Academy of Sciences (Paris); August 16, 1948.

"Measurements on Broadcast Antennas Installations—Radiation Patterns," by L. M. Malvárez, Standard Electric Argentina, August 20, 1948.

"Microwave Multiplex Transmission," by C. Baumann, Radio Corporation of America, Victor Division (Argentina); September 10, 1948.

CEDAR RAPIDS

"Stereophinic Sound for the Home," by M. Camras, Armour Research Foundation; September 15, 1948.

CONNECTICUT VALLEY

"Modern Loran Radio Station Equipment," by E. B. Redington, United States Coast Guadr Training Station; September 16, 1948.

DALLAS-FORT WORTH

"Radio Communications System of the KATY Railroad," by H. Kratiger, KATY Railroad; August 5, 1948.

DAYTON

"Microwave Communications," by J. W. McRae, Bell Telephone Laboratories; September 15, 1948.

LOS ANGELES

"Instruments for Cosmic Ray Research," by W. C. Roesch, California Institute of Technology; August 17, 1948.

"The Role of Ionization Chamber, and DC Amplifier Meters in Radiation Hazard Control," by E. Molloy, National Technical Laboratories; August 17, 1948.

NEW MEXICO

"Thunderstorms," by E. J. Workman, New Mexico School of Mines; August 27, 1948.

"Upper Atmosphere Temperatures from Remote Sound Measurements," by E. F. Cox, Sandia Laboratory; September 24, 1948.

NEW YORK

"A New Long Playing Disc Recording System," by P. C. Goldmark, Columbia Broadcasting System; September 8, 1948.

PITTSBURGH

"Recent Developments in Television Receiver Design," by F. S. Kornetz, Westinghouse Electric Corporation; September 13, 1948.

PORTLAND

"Equipment Requirements for Television Broadcast Stations," by R. J. Newman, Radio Corporation of America; September 2, 1948.

SAN DIEGO

"Factors in Television Receiver Design," C. F. Able and B. A. Penners, Western Communications Company and Consolidated Vultee Aircraft Company, respectively; September 7, 1948.

TORONTO

"C.B.C. International Broadcasting Service," by R. D. Calhoun, International Broadcasting Service, C.B.C.; April 5, 1948.

"Antenna Models," by G. Sinclair, University of Toronto; April 1948.

Election of Officers; April 19, 1948.

SUBSECTIONS

HAMILTON SUBSECTION

"Some Aspects of Design of Panel Meters," by J. R. Bach, Bach-Simpson, Ltd.; April 16, 1948.

Election of Officers; April 16, 1948.

"Construction and Characteristics of Fixed Capacitors," by J. H. Pickett, Aerovox Canada, Ltd.; May 17, 1948.

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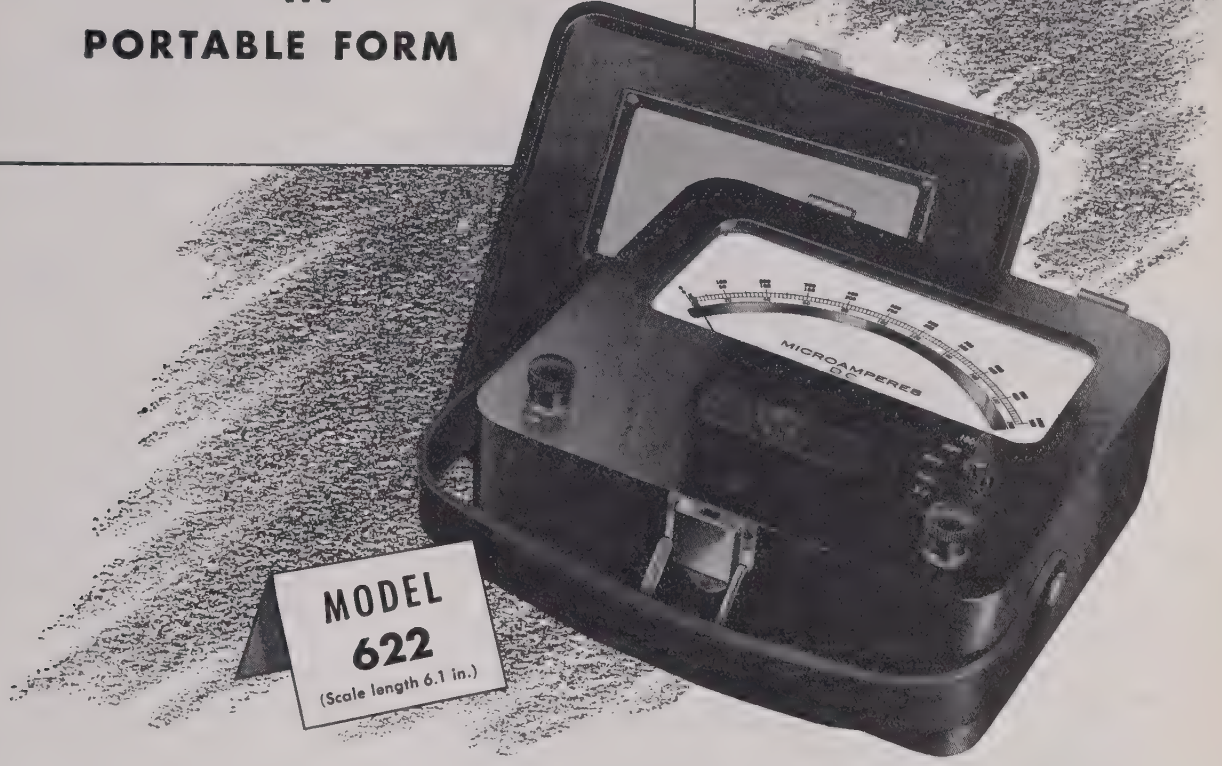

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WESTON *Instruments*

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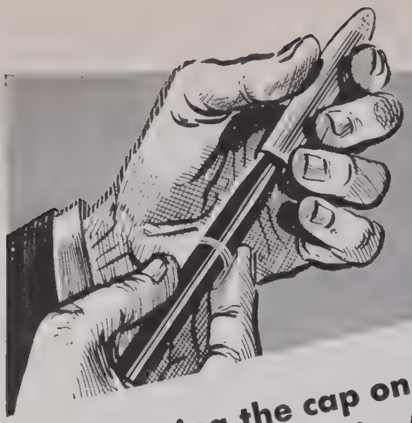
NEW ORLEANS · NEW YORK · PHILADELPHIA · PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS · SYRACUSE · TULSA · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.



as Quickly as Simply

. . as putting the cap on your fountain pen . . you change Cartridges in Astatic's FL-33 PICKUP to switch from Microgroove to 78 RPM RECORDS

No tools needed . .
No changing of needle pressure
. . Nothing else to do!

UNPARALLELED quality of reproduction of Columbia Microgroove Records is not the only advantage of Astatic's FL-33 Pickup. This new achievement of Astatic precision manufacture offers superior utility and convenience as well. Produced to Columbia's own specifications, its LP-33 Crystal Cartridge is easily, instantly replaceable with the new LP-78 Cartridge for playing conventional 78 RPM Records. No tools are needed, no adjusting of needle pressure, there is nothing else to be done. Identical in appearance, the cartridges are designed for insertion in the FL Arm on the same slip-in principle with which the modern fountain pen secures itself in its cap. The LP-78 Cartridge has a permanent sapphire needle with .003-inch tip radius, as compared with the .001-inch tip of the LP-33. Check the accompanying detailed features. Write for further information.

FEATURES OF ASTATIC'S FL-33 PICKUP

1. Five-Gram Needle Pressure.
2. Permanent Sapphire Needle with .001" Tip Radius.
3. Approximately One-Half Volt Output.
4. Frequency Range 30 to 10,000 c. p. s.
5. Novel Design at Base Eliminates Tone Arm Resonances and Assures Perfect Tracking.
6. LP-33 Cartridge for Microgroove instantly replaceable in FL Arm with LP-78 Cartridge having .003" radius needle for playing 78 RPM Records. Both simply slip into position, no tools needed, NO CHANGING OF NEEDLE PRESSURE.

FL FILTER—For best performance with high quality speakers. Controls high frequency response.

LISTED IN RADIO INDUSTRY RED BOOK

Astatic Crystal Devices Manufactured Under Brush Development Co. Patents

THE Astatic CORPORATION
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD. TORONTO, ONTARIO

MEMBERSHIP

The following transfers and admissions were approved to be effective as of November 1, 1948

Transfer to Senior Member

Bailey, L. W., 28 Browning Ave. Lenola, Moorestown, N. J.
Lichtman, S. W., 6596 Bock Rd., S.E., Washington 20, D. C.
Moffett, L., 9 Glenwolde Pk., Tarrytown, N. Y.
Nibbe, G. H., 14315 Bessemer St., Van Nuys, Calif.
Richie, S. M., 207 N. Stone Ave., La Grange, Ill.
Stevenson, M. H., c/o Radio 2UE Sydney Pty. Ltd., 29 Bligh St., Sydney, N.S.W., Australia
Wilkins, A. F., "Deva" Cliff Road, Felixstowe, Suffolk, England

Admission to Senior Member

Barlow, E. J., 48 Roydon Dr. E., Merrick, N. Y.
Kirkman, R. A., 1910 Oak Dr., West Belmar, N. J.
Peixoto, E. S., S. A. Varig, Box 243, Porto Alegre, RS, Brazil
Ponte, M. J. H., 3 Rue Villaret De Joyeuse, Paris 17, France

Transfer to Member Grade

Arnold, H. H., Box 3031, Winston Salem, N. C.
Bernstein, J., 1363 Findlay Ave., New York 56, N. Y.
Bey, W. I., Box 1545, Fargo, N. Dak.
Carew, S. J. H., 358 Bessborough Dr., Toronto, Ont., Canada
Chasteen, J. W., 3717 E. 12 St., Kansas City, Mo.
Fiske, J. J., 2031 Vista Del Mar Ave., Los Angeles 28, Calif.
Fonda-Bonardi, G., 1723 Golden Ave., New York 60, N. Y.
Graham, W. B., 51 St. Luke Pl., Franklin Square, L. I., N. Y.
Hall, E. G., R.F.D. 2, County Farm Road, Lafayette, Ind.
Haubrock, F. W., 2329 Blake St., Berkeley 4, Calif.
Legault, E. G., 422 Mt. Royal E., Montreal, Que., Canada
Price, R. L., 3277 Wrightwood Ave., Chicago 47, Ill.
Subrahmanyam, G., Box 152, International House, 500 Riverside Dr., New York 27, N. Y.
Suchard, D. G., 90 Adelaide St. S., London, Ont., Canada

Admission to Member Grade

Beisel, R. W., 1421 Eagle Dr., Fort Worth 11, Tex.
Carpenter, R. C., 2807 Blaine Dr., Chevy Chase 15, Md.
Green, J. W. Jr., Professor of Electricity, U.S.M.A., West Point, N. Y.
Halliday, O. T., 2415 Brazoria, Houston 6, Tex.
Howe, D. W., Jr., 29 Chadwick St., Worcester 5, Mass.
Johnson, D. L., 7101 E. Zion St., Tulsa 15, Okla.
LaGrone, A. H., Box F, University Station, Austin 12, Tex.
Shipp, R. L., Jr., 3407 Earlham Dr., Dayton 6, Ohio
Taylor, B. M., 4661 El Cerrito Dr., San Diego 5, Calif.
Watkins, W. B., Jr., 4015 Fairy Dr., Louisville, Ky.
Williams, J. B., Philco Corp., Tioga & C. Sts., Philadelphia 34, Pa.

The following admissions to Associate grade have been approved and were effective as of October 1, 1948

Allison, D. B., 835 N. Kansas, Hastings, Neb.
Babb, J. M., Wakeeney, Kan.
Bales, E. D., Sandia Base Branch, Albuquerque, N. M.
Beraducci, S., 260 Union St., Brooklyn 31, N. Y.

(Continued on page 39A)

MEMBERSHIP

(Continued from page 36)

Bhandari, J. N., Electrical Communication Engineering, Indian Institute of Science, Bangalore 3, India
Bisaria, J. N., E. C. Department, Indian Institute of Science, Banglore 3, India
Braun, A., Rousseaustr. 94, Zürich, Switzerland
Buchtel, P. E., 2245 13 St., Akron 14, Ohio
Busler, L. F., Jr., 60 N. Willett St., Memphis 4, Tenn.
Chapman, L. B., 2459 Parkview Ave., Toledo 6, Ohio
Davis, S. E., Radio Station WCNR, 38 W. Main St., Bloomsburg, Pa.
DeBell, J. M., Jr., 5 Albion St., Passaic, N. J.
Dilson, J., 535 E. 14 St., New York 9, N. Y.
Dotson, E., 111 N. Metcalf, Lima, Ohio
Dumas, K. L., 4022 Corby St., Omaha, Neb.
Escher, P. H., 309 Las Casas, Pacific Palisades, Calif.
Everhart, W. H., 136 A Eighth St., Sandia Base Branch, Albuquerque, N. M.
Franklin, P. E., 401 Caroline, Houston 2, Tex.
Gottschalk, M., 37 W. 52 St., New York 19, N. Y.
Hall, R. W., c/o KFMX-KSWI, Council Bluffs, Iowa
Hammer, W. A., Managing Director, Autophon A. G., Soleure, Switzerland
Hennigar, N. E., Box 12, Newport Beach, Calif.
Hodge, C. E., 1330 W. Fourth St., Winston Salem, N. C.
Hutton, W. I., 3545 South St., Lincoln 6, Neb.
Janardhan, N. M., Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, India
Kimble, J. A., Radio Station KWBB, 351 N. Topeka, Wichita 2, Kan.
Lavin, H. P., 803 N. Bellevue, Hastings, Neb.
Ludebid, M. L., Brasil 975, 3er Psio, Buenos Aires, Argentina
Miles, R. B., 4534 Lake Park Ave., Chicago 15, Ill.
Molloy, G. C., 1323 Madison Ave., Baltimore 17, Md.
Newman, L., 191 Central Ave., Newark 4, N. J.
Phillips, P. C., 322 W. Ruscomb St., Philadelphia, Pa.
Rappaport, R. B., 4140 Buckingham Rd., Los Angeles, Calif.
Rector, C. V., 1617 W. Carter St., Kokomo, Ind.
Reid, T. C., 1514½ Gordon St., Hollywood 28, Calif.
Reinsch, F. J., 445 W. 118 St., Los Angeles 3, Calif.
Robertson, A. J. L., 5540 Saylor, Lincoln 6, Neb.
Robinson, R. J., Longhill Rd., R.F.D. 1, Little Falls, N. J.
Ross, I. L., 228 E. Sheldon St., Philadelphia, Pa.
Rudd, F. A., 3676 Ida St., Omaha 11, Neb.
Sangiovanni, E. R., San Juan 2631, ler Piso, Buenos Aires, Argentina
Sheffrey, T. N., 1337 N. 39 St., Lincoln, Neb.
Sibilia, L., 714 S. 38 Ave., Omaha 5, Neb.
Sims, T. W., 54 Bluegrass, Fort Thomas, Ky.
Skolnik, S., Milner Hotel, 131 W. Fifth St., Dayton 2, Ohio
Smith, H. B., 467 Park Ave., Birmingham, Mich.
Steves, P. J., 115 W. 63 St., New York 23, N. Y.
Stropki, G. T., 3333 N. Marshfield Ave., Chicago, Ill.
Subrahmanyam, D. L., Technical Assistant, Research Department, All India Radio, Curzon Road, New Delhi, India
Swanson, D. A. KMMJ Transmitter, Phillips, Neb.
Von Utfall, J. C., United Nations Sound and Recording Section CA-041, Lake Success, N. Y.
Wallace, B. E., Jr., Randallstown, Md.
Washburn, C. A., 203 N. Edith St., Albuquerque, N. M.

(Continued on page 40A)

An Important Statement

by

MYCALEX

CORPORATION OF AMERICA

An explanation of the properties and advantages of Mycalex (glass bonded mica) 410, Mycalex 400, and Mycalex K are given on the opposite page.

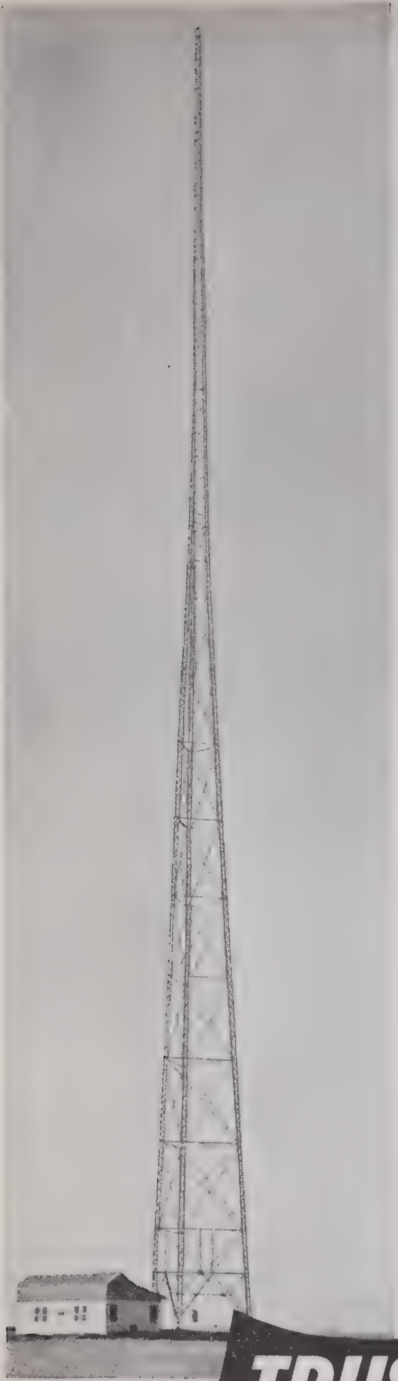
Your attention is also called to the Mycalex 410 advertisement which appeared on pages 30 and 31 of the October 1948 issue of Proc. of I.R.E.

Constant research, improved technics, advances in the art, new, modern plant expansion, improved engineering, more efficient manufacturing equipment—now permit us to make available in increased quantities—Mycalex 410—molded—*at prices comparable* to other less efficient molded insulations.

MYCALEX 410 is now priced to meet rigid economy requirements

Any interest evidenced on your part in Mycalex products and services—will receive the prompt, courteous and intelligent attention of a competent Mycalex sales engineer. He will receive the fullest backing and cooperation from other factory executives—to serve you promptly—with a quality product and at an economical and fair price.

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.



KSAC

Manhattan, Kansas

On the broad, flat Kansas plains, this Truscon Radio Tower stands out as a monument of service dedicated to the people of a great area. This station is operated by the Kansas State College of Agriculture and Applied Science.

Truscon Radio Towers have a great record for service, strength and stability all over the United States and in foreign countries, operating in a wide range of wind, temperature and humidity conditions. The knowledge gained from such a diversity of installations assures you highly competent engineering service.

Truscon Radio Towers are available in guyed or self-supporting types, either tapered or uniform cross section, for AM, FM and TV broadcasting. Experienced Truscon radio tower engineers will be glad to help solve your radio tower problems of today and tomorrow.

Radio Station KSAC, Manhattan, Kansas, uses a Truscon Self-Supporting Tower 425 feet high.

TRUSCON SELF-SUPPORTING AND UNIFORM CROSS SECTION GUYED TOWERS

TRUSCON STEEL COMPANY
YOUNGSTOWN 1, OHIO
Subsidiary of Republic Steel Corporation

Manufacturers of a Complete Line of Self-Supporting Radio Towers . . . Uniform Cross-Section Guyed Radio Towers . . . Copper Mesh Ground Screen . . . Steel Building Products.

MEMBERSHIP

(Continued from page 39A)

Watson, R. V., 48 High St., Hoddesdon, Hertfordshire, England
Weston, L. Y., Jr., Electronic Computer Project, Institute for Advanced Study, Princeton, N. J.

The following transfers to Associate grade were approved to be effective as of October 1, 1948

Bennett, W. C., 5819 Kingman Blvd., Des Moines 11, Iowa
Chang, S-H., 77 Duston St., Brighton 35, Mass.
Gauthier, L. P., 59 Rangely Rd., West Newton, Mass.
Guida, J. A., c/o Dr. E. B. Kent, Arlington, Vt.
Huang, T-S., c/o Mr. C. Y. Huang, 271 Foochow Rd., Shanghai, China
Hurwitz, M. L., 7709 Yates Ave., Chicago 49, Ill.
King, G. L., 480 Albert St., Kingston Ont., Canada
Lenoir, S. P., Jr., Prairie, Miss.
McAuley, J. H., 956 Myrtle St., N.E., Atlanta, Ga.
Normando, N. J., 600½ Grove St., Jersey City, N. J.
Pearsall, S. H., 612 Russell St., Nashville, Tenn.
Vendeland, R. N., 711 E 258 St., Euclid 23, Ohio

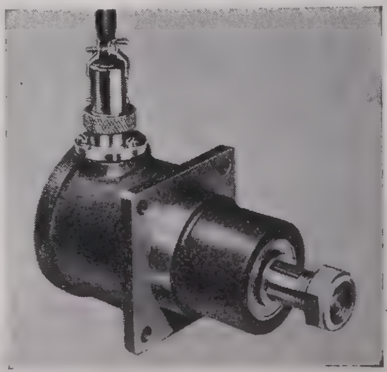
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

Small Tachometer

A new, rugged, small electric tachometer, designed for continuous operation, has just been announced by **The Electric Tachometer Corp.,** 2218 Vine St., Philadelphia 3, Pa.



This unit, Model M-1200, measures only $2\frac{3}{4}'' \times 5\frac{3}{8}''$, is housed in cast bronze, and will operate in any position through a wide range of temperatures.

Various drive-shaft arrangements and a suitable assortment of indicating meters are available to cover all operating conditions.

Booklet M-120 gives complete descriptive information.

(Continued on page 44A)

Soup-or Duck Soup?

GCA* makes the difference! Aviation's dread bogey—fog—has been scratched.

In 36 states, 15 foreign nations, nearly two hundred GCA-equipped airports now carry on routine transport operations in all weather. Pilots land 'instrument'. . . without incident.

As original manufacturer of the GCA radar landing system, Gilfillan has pioneered most of its refinements. Five-man, multi-scope trailer equipment has been engineered down to a trim one-man, two-scope unit in the control tower. Latest GCA self-powered military units are streamlined, air transportable.

Outstanding new GCA feature is the AZEL three-dimensional scope, which combines elevation, range and azimuth data. MTI (Moving Target Indicator) is another. Eliminating all ground clutter, it gives sharp definition to every airborne aircraft within a 30-mile radius.

GCA means pilot assurance and passenger confidence. Helping the aviation industry to achieve dependable air transportation is Gilfillan's determined objective.

**Ground Controlled Approach.*

GCA

Gilfillan
LOS ANGELES

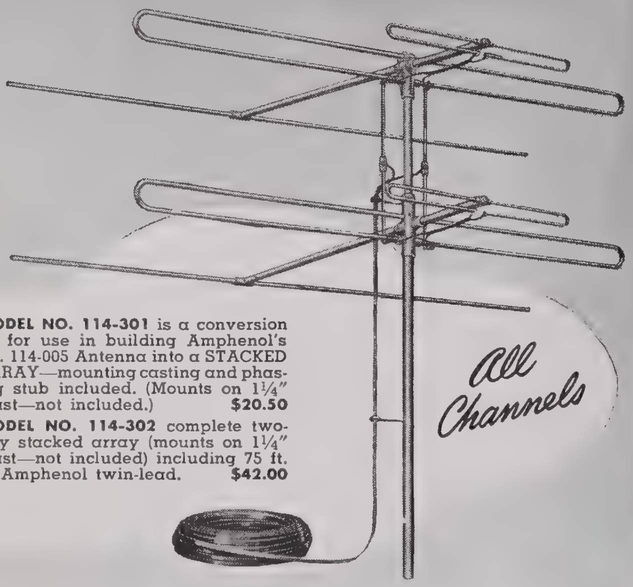
RCA International Division, New York, N. Y.
Exclusive Export Distributor

db GAIN + + +

more *signal strength* for greater distance and the *best picture*

with **AMPHENOL**

STACKED ARRAY



MODEL NO. 114-301 is a conversion kit for use in building Amphenol's No. 114-005 Antenna into a STACKED ARRAY—mounting casting and phasing stub included. (Mounts on 1¼" mast—not included.) **$20.50**

MODEL NO. 114-302 complete two-bay stacked array (mounts on 1¼" mast—not included) including 75 ft. of Amphenol twin-lead. **$42.00**

Stacked Array multiplies the universally acknowledged features of the Amphenol All-Channel TV Antenna (No. 114-005). Stack to provide reception at greater distances—Stack for picture brilliance and clarity—Stack for controlled TV reception. Provide the *TV Receiver* with the *Best Antenna* to Produce the *Best Picture*. Amphenol's Stacked Array is your assurance of top TV picture quality.

Performance Charts Available

If you are not now receiving the monthly AMPHENOL ENGINEERING NEWS—you will want to request the September issue which includes pattern and gain charts for the Stacked Array. We will be glad to mail it and to place your name on our list to receive future issues—write Dept. 13D.

AMPHENOL
ENGINEERING NEWS

AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE, CHICAGO 50, ILLINOIS
COAXIAL CABLES AND CONNECTORS · INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT · ANTENNAS · RADIO COMPONENTS · PLASTIC FOR ELECTRONICS

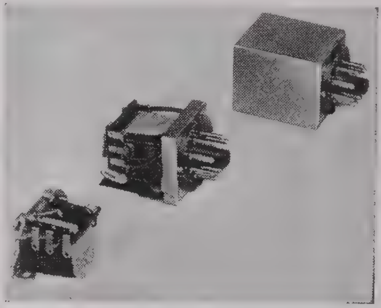
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 40A)

AC, DC or Half-Way Rectified AC Relay

A new miniature relay, Type 118XBX, is now on the market from **Struthers-Dunn Ind.,** 150 N. 13th Street, Philadelphia 7, Pa.

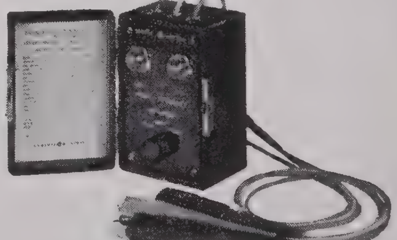


This open-type relay has double-pole double-throw contacts, rated at 2 amperes at 115 volts ac, is 1½" high, 1½" long, and 1" wide, and weighs approximately 2 ounces.

If required, it may be housed in a metal enclosure 1⅜" long and wide by 1¾" high and equipped with a tube-type octal base. It is also adaptable to hermetic sealing.

Phase-Sequence Indicator

A new phase-sequence indicator designed for a wide range of applications in the manufacturing, industrial, and central-station fields has been announced by the *Meter and Instrument Divisions,* of **General Electric Co.,** Schenectady 5, N. Y.



This indicator is entirely static, with no moving parts, bearings, or pivots. The indicator is applicable to either 120-, 240-, or 480-volt circuits at 25, 50, and 60 cps.

It may be used to predict the directional rotation of polyphase meters for machine drivers, elevators, air-conditioning equipment, and similar devices; to determine the proper connections for paralleling generators, transformer banks, and power buses; to determine proper connections for watthour meters, reactive-component meters, power-factor meters, kva meters, reverse-power relays, and phase-sequence relays; to check electron-tube, thyratron, rectifier, and inverter installations; and to study vector relations of polyphase circuits.

(Continued on page 46A)

If it's Electronic . . .

B&W CAN MAKE IT FOR YOU

From small electronic components up to carefully engineered test equipment and complex electronic devices, Barker and Williamson can engineer and manufacture high quality products to your specifications.

Three B&W plants, comprising 150,000 square feet, completely equipped with a competent engineering staff, machine shop, tool room (including all machines for drilling, milling, turning, stamping and forming metals and plastics), and a complete woodworking shop are at your disposal. Your inquiries are welcome. Write Department PR-118 for prompt reply.

NOW IN PRODUCTION AT B & W

COMPLETE RADIO TRANSMITTERS • DUAL DIVERSITY CONVERTERS, CONTROL UNITS and FREQUENCY SHIFT EXCITERS FOR RADIO TELETYPE TRANSMISSION • SPECIAL TEST EQUIPMENT • REDESIGN, MODERNIZATION AND MODIFICATION OF EXISTING EQUIPMENT MACHINE WORK • METAL STAMPING • COILS CONDENSERS • OTHER ELECTRONIC DEVICES IN A WIDE RANGE OF TYPES

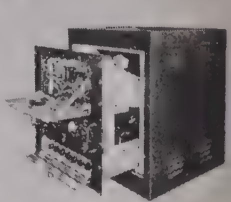
PLANT No. 2
BRISTOL, PA.
BARKER AND WILLIAMSON

ARKER & WILLIAMSON, Inc.

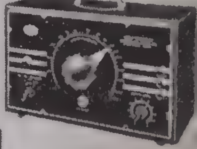
—Provides RF drive and frequency shift keying to transmitter.

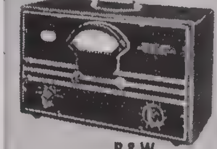
2 KW AMPLIFIER—Class C R-F Amplifier. Frequency Range 1 to 25 Mc's.

CONTROL UNIT—Operat as an electronic repeater teletype wire lines.

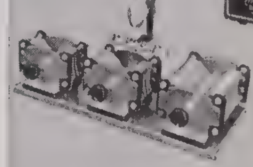

DUAL DIVERSITY CONVERTER — Provides diversity mixing on frequency shift circuits.

RECEIVER ASSEMBLY —Standard Army BC-342 Receivers modified for Dual Diversity Reception Coupling Amplifier bottom, front.

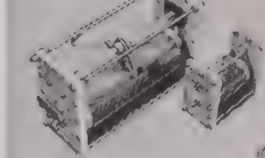

B&W AUDIO OSCILLATOR
Model 200


B & W FREQUENCY METER
Model 300

B & W
DISTORTION METER
Model 400


B & W SMALL BUTTER
VARIABLE CAPACITO

B & W TURRETS

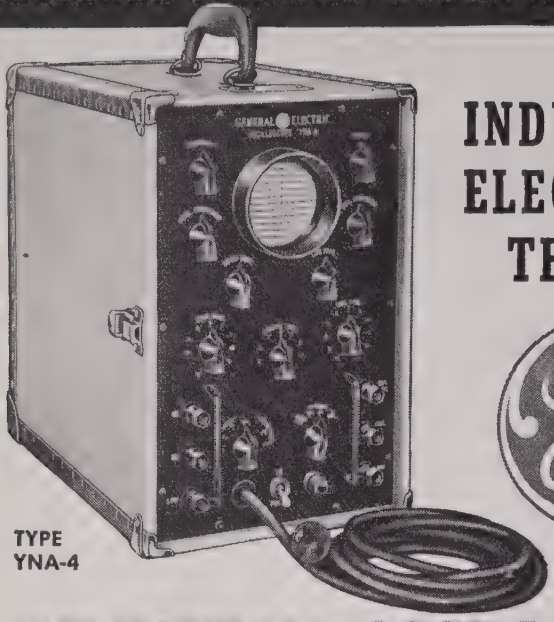

B & W ROTARY CO

B & W HEAVY DUTY
VARIABLE CAPACITOI

B & W 3400

DESIGNED FOR ONE SPECIFIC PURPOSE—

INDUSTRIAL ELECTRONIC TESTING



TYPE YNA-4

INDUSTRIAL OSCILLOSCOPE

Check—Measure—Test—with the G-E Industrial Oscilloscope.

The following partial list of uses will indicate its importance where ever electrical apparatus is employed.

For checking welding equipment, testing photo-electric circuits, checking performance of relay contacts, performance of high power rectifier tubes, measuring voltage and current relationship in motors, performance of commutators, checking audio oscillators—the YNA-4 Industrial Oscilloscope performs all these important checking and testing functions most efficiently.

D-C Amplifiers for Horizontal and Vertical Deflection—Give a true trace combining both the AC and DC components important for industrial purposes which is not possible with the ordinary oscilloscope used in radio work.

Completely Insulated Case—Since the entire unit is insulated, it may be operated as high as 550 volts above ground. Instrument may be placed on metal working surfaces, machinery, and other advantageous working spots even when connected to ungrounded circuits.

Internal Calibrating Voltages—The YNA-4 provides internal calibrating voltages of known value to enable the operator to set the deflection sensitivity of the oscilloscope. Functions as a vacuum tube voltmeter permitting AC and DC voltage measurements without a voltmeter.

Flexible Input Circuits—Vertical Amplifier—varied inputs are available to accommodate a wide range of voltages and circuit requirements. This oscilloscope may be used to examine voltages from 1.0 volt to 500 volts and its input impedance may be switched from 1 megohm to 10 megohms or to open grid.

Horizontal Amplifier—direct coupled input terminals are provided or the built-in sweep generator may be used for horizontal deflection. This generator may be synchronized with the power line, the vertical amplifier or with an external source.

Wide Sweep Frequency Range—The YNA-4 has been designed so that the operator can observe separate cycles over a wide band of frequencies. A minimum sweep rate of 10 cycles has been established as desirable for industrial operations—this has been incorporated in YNA-4.

For complete information on the YNA-4 Industrial Oscilloscope and other precision measuring equipments write today to: *General Electric Company, Electronics Park, Syracuse, New York.*

165-G8

GENERAL ELECTRIC

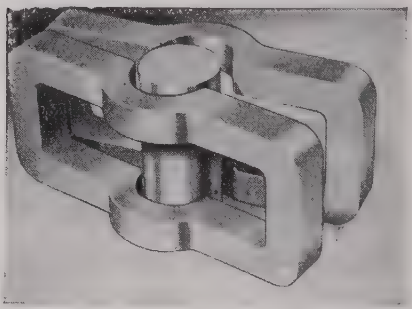
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 44A)

Powdered-Iron Transformers For Television Deflection

A core fabricated in powdered iron is being made by **Henry L. Crowley & Co., Inc.,** West Orange, N. J., that is claimed by the manufacturer to reduce costs to less than one quarter those of equivalent laminated-sheet or strip metal types.



It consists of a two-piece frame and center slug assembly for television receiver deflection transformers, and with proper windings held by this transformer core structure there is provided a low-loss energy-recovery system requiring no additional electrical energy yet providing large increases in deflection capability.

Depending upon molding pressures ranging from 15 tons to upwards of 60 tons per square inch, the degree of dc saturation and again the peak amplitude of ac flux density, effective ac permeabilities of the order of 40 to 230 are available in these assemblies. High-Q systems are attainable at low cost because of the small particle thickness obtainable. The stepped-up efficiency eliminates the necessity for dissipating large amounts of energy from the transformer and deflecting-yoke structures. Furthermore, it is claimed, the molded core structure produce negligible hum noise in comparison with laminated-core structure.

A single driver tube with a single damper tube and two small rectifier tubes can provide full deflection as well as second-anode high voltage for a 50° cathode-ray tube, at accelerating voltages up to 17 kilovolts, under present tube ratings.

Recent Catalogs

• • • A 44 page booklet containing much helpful data for selecting and applying brushes for longer life and better performance on a wide variety of small motor equipment entitled "Fractional Horsepower Equipment Brush User's Guide" by **Stackpole Carbon Co.,** St. Marys, Pa.

• • • On a new capacitor type filter to control radio interference caused by fluorescent lamps, by **Cornell-Dubilier Electric Corp.,** South Plainfield, N. J.

(Continued on page 48A)

Wireless World
RADIO AND ELECTRONICS
WIRELESS ENGINEER
AUGUST

For Accurate and Up-to-date News of Every British Development in Radio, Television and Electronics

WIRELESS WORLD is Britain's leading technical magazine in the general field of radio, television and electronics. For over 37 years it has consistently provided a complete and accurate survey of the newest British technique in design and manufacture. Articles of a high standard include reviews of equipment, broadcast receivers and components, while theoretical articles deal with design data and circuits for every application.

WIRELESS ENGINEER is read by research engineers, designers and students, and is accepted internationally as a source of information for advanced workers. The Editorial policy is to publish only original work, and representatives of the National Physical Laboratory, the British Broadcasting Corporation and the Engineering Department of the British Post Office are included on the Editorial Advisory Board.

Subscriptions can be placed with British Publications Inc., 150 East 35th Street, New York. 16, N.Y., or sent direct by ASSOCIATED ILIFFE PUBLICATIONS *International Money Order to Dorset House, Stamford Street, London, S.E.1, England. Cables : "Iliffepres, Sedist, London."*

ASSOCIATED TECHNICAL BOOKS: "Television Receiving Equipment" (2nd Edition), by W. T. Cocking, M.I.E.E. One of the most important British books on television, 13 shillings ($2.60): "Wireless Direction Finding" (4th Edition), by R. Keen, B.Eng. (Hons.), A.M.I.E.E An up-to-date and comprehensive work on the subject, 45 shillings ($9.25): available from the British address above

For TV and FM

Standardize on One!

Now, ONE crystal holder will cover your requirements for television and frequency modulation transmission. RH-7 hermetically sealed crystal units offer a frequency range from 1 to 75mc, to tolerances as close as ± .0002%. Space-saving, easily installed and replaced, RH-7 crystals will fit all circuits. Two pin sizes or wire leads are available.

Why not standardize now, on just ONE!

REEVES-HOFFMAN CORPORATION

CHERRY AND NORTH STREETS • CARLISLE, PA.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 46A)

DC-AC Chopper

The type 222 Chopper, an electromechanical chopper or rectifier (demodulator) is a new product being manufactured by **Stevens-Arnold Inc.,** 22 Elkins Street, South Boston 27, Mass.

DC-AC
CHOPPER
PATENT PENDING
TYPE 222
STEVENS-ARNOLD
SOUTH BOSTON, MASS

When used as a chopper, it will convert pure dc into pulsating dc or ac so that the output of thermocouples, strain gauges, or other low-level dc sources may be amplified by means of an ac rather than a dc amplifier. As a rectifier, it will convert ac to dc. As the principal element in a square-wave generator, it may be used to produce square waves in the range of 10 to 500 cps.

The single-pole, double-throw contacts may be open or closed on either or both contacts when the armature is at rest, because there are two independent floating armatures inside the chopper. The nominal rating is 0.050 amperes, 50 volts dc. The maximum rating is ½ ampere, 110 volts dc.

The coil—fully shielded electrostatically—is rated at 12 volts, 10 to 500 cps, but this may be increased to 24 volts without damage.

Recent Catalogs

• • • This is a list of available bulletins and catalogs of an English firm: type No. 623 Electronic Process Timer; type No. 701 H. F Signal Generator; type No. 702, Low Frequency Signal Generator; type No. 703 Bridge Oscillator and Amplifier Detector; type No. 704 Electronic Decade Counter; type No. 705 Stabilized Power Supply unit; type No. 708 Power Output Meter; type Nos. 707 & 713 Electronic Heat Generators; type No. 712 Valve Voltmeter; type No. 723 DC Oscilloscope; type No. 726 Frequency Meter (Tachometer; type No. 732 Electronic Ionization and Insulation Tester; type No. 734 Photocell Unit, by **Airmec Laboratories, Ltd.,** 19 Charterhouse St., London, England.

(Continued on page 60A)

Positions Wanted

(Continued from page 58A)

TELEVISION ENGINEER

Graduating American Television Institute of Technology November 1948 with B.S.T.E. Age 26. Married. 1st class F.C.C. license. 4 years maintenance Navy radio equipment. Trained in Operation and Maintenance of R.C.A. Image Orthicon and DuMont equipment. Desires position in television broadcasting field. Box 192W.

JUNIOR ENGINEER

Three years electrical engineering college, major in electronics, continuing studies for B.S. in E.E. at night. Desires work as Junior Engineer in design and development of communication equipment under Senior Engineer. Prefer Long Island. Box 193W.

ENGINEER

Graduating University of Michigan August 1948 with B.S.E.E. in communications. Age 24. Married. Two years Army radar (G.C.A.) Two years shop experience. Interested in sales or development engineering. Prefer midwest area. Box 194W.

JUNIOR ENGINEER

Graduate R.C.A. Institutes. Age 27. Married, 1 child. Desires work West Coast in television, radio, electronics research or development. Limited Air Force experience. Ambitious, persevering. Box 195W.

ENGINEER

Experienced in electrical, electronics and mechanical fields. Desire permanent position in management with West Coast firms. Can handle men. Age 33, B.S. in E.E. Available this fall. Interview at your expense; brochure free to interested firms. Box 202W.

TECHNICAL EXECUTIVE

Engineering Physicist, MA, Gold medallist, 30, experienced in radio, radar and X-ray, division manager Montreal branch of European concern wants change to progressive North American concern that can use his talents not necessarily in these fields. Box 203W.

ELECTRONIC ENGINEER

Currently engaged in production, design and development work for capacitor manufacturer, desires position in electronic industry within Chicago area. B.S.E.E. January 1948 Illinois Institute of Technology. Communications major. Age 25. Married. Two years Navy Electronic experience including supervision of Radio Teletype Station. Box 204W.

AN ENTIRELY NEW
Dependable
AUTOMATIC DEHYDRATOR
BY
Andrew

For pressurizing coaxial systems with dry air

WRITE FOR BULLETIN 85

Now, for the first time, here is an automatic dehydrator that operates at line pressure! This means, (1) longer life, and (2) less maintenance and replacement cost than any other automatic dehydrator.

Longer life because the compressor diaphragm operates at only 1/3 the pressure used in comparable units, vastly increasing the life of this vulnerable key part.

Reduced maintenance and replacement costs because new low pressure design eliminates many components.

Operation is completely automatic. Dehydrator delivers dry air to line when pressure drops to 10 PSI and stops when pressure reaches 15 PSI. After a total of 4 hours' running time on intermittent operation, the dry air supply is turned off and reactivation begins, continuing for 2 consecutive hours. Absorbed moisture is driven off as steam. Indicators show at a glance which operation the dehydrator is currently performing.

Output is 1¼ cubic feet per minute, enough to serve 700 feet of 6⅛″ line; 2500 feet of 3⅛″ line; 10,000 feet of 1⅝″ line or 40,000 feet of ⅞″ line. Installation is simple, requiring only a few moments.

Important! Not only is this new differently designed Andrew Automatic Dehydrator completely reliable, but it is available at a surprisingly low price.

Andrew
CORPORATION
363 E. 75th STREET, CHICAGO 19
Eastern Office:
421 Seventh Avenue, New York City

ANDREW

TRANSMISSION LINES FOR AM, FM, TV. DIRECTIONAL ANTENNA EQUIPMENT. ANTENNA TUNING UNITS. TOWER LIGHTING EQUIPMENT. CONSULTING ENGINEERING SERVICE.

MAIL COUPON NOW!

MAIL COUPON NOW!

ANDREW CORPORATION, 363 E. 75th St., Chicago 19

Please send me Bulletin 85 describing the new Type 1900 Andrew Automatic Dehydrator.

Name____________________
Title____________________
Company____________________
Address____________________
City__________Zone____State______

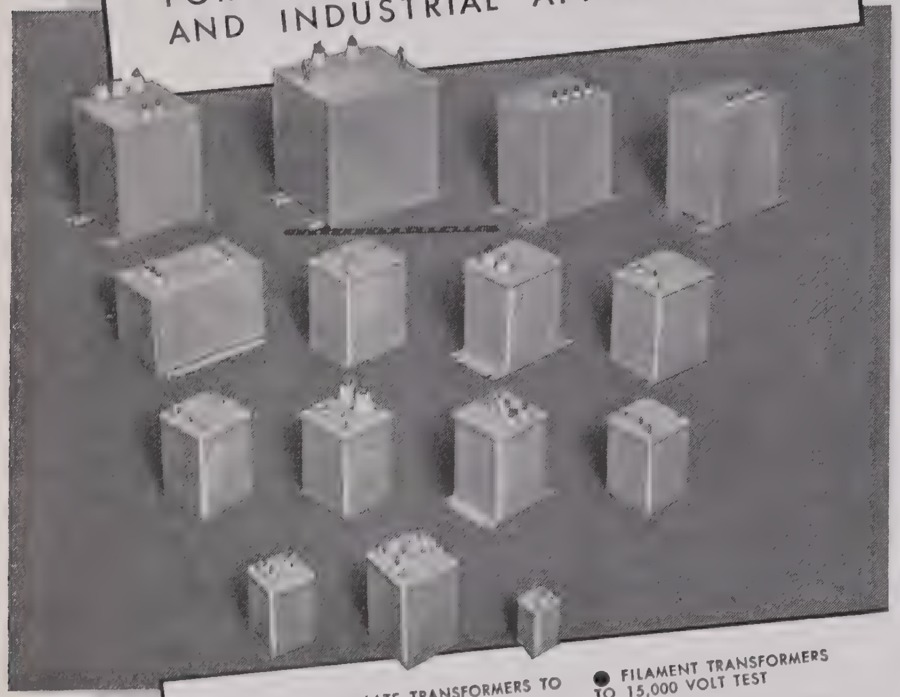
IRE 11-48

New! All inclusive!

N Y T

STANDARD LINE OF TRANSMITTER COMPONENTS

FOR AM, FM AND TV—LABORATORY AND INDUSTRIAL APPLICATIONS



INCLUDING—

- PLATE TRANSFORMERS TO 10 KVA
- FILTER REACTORS
- FILAMENT TRANSFORMERS TO 15,000 VOLT TEST
- PLATE FILAMENT TRANSFORMERS LOW VOLTAGE

FEATURING—

- 115/230 VOLT, 50/60 CYCLE SUPPLY
- RUGGED INTERNAL CONSTRUCTION, SUPPORTED CORE STRUCTURE
- EYE BOLTS ON LARGE UNITS FOR EASY HANDLING
- AIEE SURGE TEST ON HIGH VOLTAGE UNITS
- EFFICIENT MAGNETIC AND ELECTRO-STATIC SHIELDING
- UNIFORM STREAMLINED APPEARANCE
- STURDY STEEL CASES

Here is one of the finest and most complete lines of standard transmitter components available today. Built to the same well-known high standards as N·Y·T custom-built units, they bring to the design engineer the full economy of standardized construction. Superbly constructed, inside and out, each unit fully reflects the years of experience that have made the name NEW YORK TRANSFORMER synonymous with quality, integrity and dependability wherever inductive components are used.

WRITE
FOR
CATALOG

NEW YORK
TRANSFORMER CO., INC.
ALPHA, NEW JERSEY

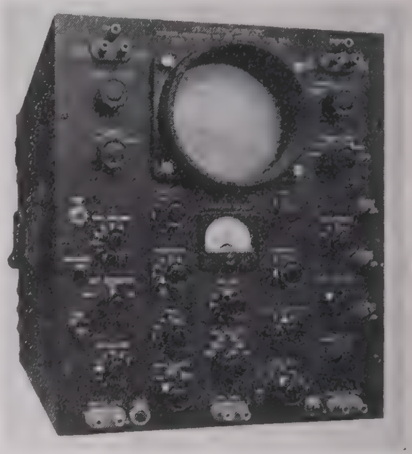
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Model OL-15B Oscillosynchroscope

The Model OL-15B Oscillosynchroscope, which is a new laboratory instrument for observation of transient and recurrent phenomena involving wide ranges of frequencies, is being manufactured by **The Browning Laboratories, Inc.,** 742-750 Main St., Winchester, Mass.



A 5-inch cathode ray tube with 4000 volts accelerating potential provides superior intensity and definition of images. Other features include a vertical amplifier bandwidth of 6 Mc, recurrent sweeps of 5 to 500,000 per second and driven sweep rates of 0.25 to 200 microseconds per inch. An internal trigger generator is also provided, as well as a variable delay circuit which may be used to provide delayed triggers or a delayed sweep either internally or externally triggered. A calibration device provides measurement of deflection sensitivity through the amplifier.

The vertical amplifier, which is linear without positive slope from 10 cps to 6 Mc, has a transient response such that a 100-kilocycle square wave which rises or falls at the rate of 500 volts per microsecond is faithfully reproduced.

Dimensions: $13\frac{1}{4}''\times 14\frac{3}{4}''\times 19\frac{3}{4}''$, weight 95 lbs.

Recent Catalogs

• • •On a volt-ohm-milliammeter with a direct current sensitivity of 20,000 ohms per volt. Classified as the Roto-Ranger this instrument is being manufactured by **Simpson Electric Co.,** 5200-18 W. Kinzie St., Chicago 44, Ill.

• • •A 15 page illustrated bulletin, No. CDP-578, describing molded and laminated plastics, and an 8 page illustrated bulletin, No. CDM-12 describing metallurgical products by the **General Electric Co., Chemical Dept.,** Pittsfield, Mass.

(Continued on page 63A)

Wires drawn to .0004" diameter.
WIRE & RIBBON
MICRODIMENSIONAL
FOR VACUUM TUBES
Ribbon rolled to .0001" thickness.
Alloys for Special requirements.
WRITE for list of stock alloys.

SIGMUND COHN CORP.
44 GOLD ST., NEW YORK
SINCE 1901

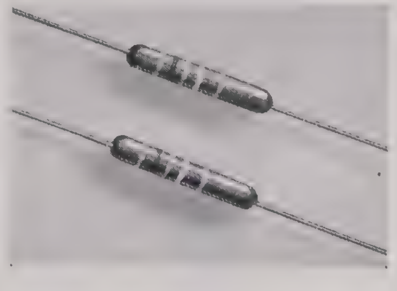
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

Extreme Temperature Range Capacitors

The Sprague Prokar capacitors, designed to comply with unusual temperature extremes to which military electronic equipment is subjected, are now in mass production and available from the **Sprague Electric Co.,** North Adams, Mass.



It is claimed that these small, new molded tubulars are impregnated with a new high-temperature plastic that permits a considerable size and performance advantage at high temperatures over other known impregnants and provides stable performance under all operating conditions.

They are rated for operation from −50°C to +125°C. Full details are available in the company's Engineering Bulletin 221.

Fluorescent Lamp Capacitor

For use in cold-cathode flourescent lamp equipment, the Type KX-103 capacitor is now being produced by **Cornell-Dubilier Electric Corp.,** South Plainfield, N. J.

Three capacitor elements are combined in a rectangular case $2\frac{1}{8}'' \times 2\ 13/16'' \times 2\frac{3}{4}''$.

The specifications are: 0.006–0.006 μf, 750 volts ac, and 0.51 μf, 1050 volts ac. The same type and style is available in other capacity combinations, single or multiple units, at voltages up to 1200 volts ac.

Recent Catalogs

• • • "Micro Tips," Volume 1, No. 2, has useful suggestions concerning applications of snap-action switches, published by **Micro Switch,** Freeport, Ill.

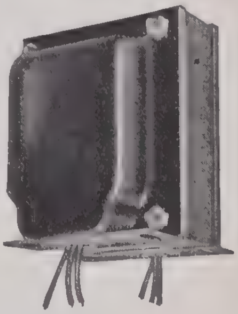
• • • A catalog sheet describing the new series 710, electronically regulated power supplies, by **Furst Electronics,** 800 W. North Ave., Chicago 22, Illinois.

(Continued on page 64A)

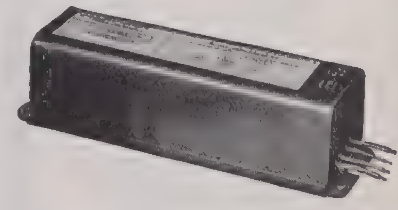
What are Your
TRANSFORMER SPECIFICATIONS?

Would a slight change from the "standard" electrical specifications improve the performance of your finished product? If so, get in touch with Acme Electric engineers for assistance in designing a "special" transformer from standard parts.

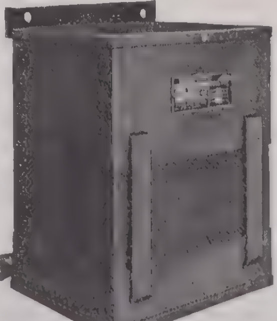
For television, radio, and other electronic applications, Acme produces a wide variety of transformers all with different specifications from standard parts. This means better performance, better quality and often at economy prices.



ENCLOSED TYPES



The dies for making transformers that fit into this enclosed case, alone would cost you thousands of dollars. Acme produces to save you this expense.

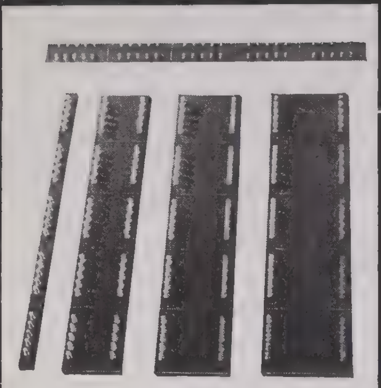


Here is a typical air-cooled design which can be produced to meet a variety of applications. Write for Bulletin 168A for further details.

ACME ELECTRIC CORP.
4411 WATER ST. CUBA, N. Y.

Acme ACME Electric
TRANSFORMERS

Save Time... Speed Assembly with CTC ALL-SET Boards!



On the assembly line and in the laboratory, CTC *ALL-SET* Boards are valuable time-savers.

With Type 1558 Turret Lugs, a new board now offers mounting for miniature components. 1 1/16″ wide, 3/32″ thick, only. (Type X1401E.)

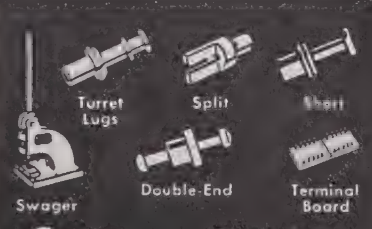
With Type 1724 Turret Lugs, boards come in four widths: ½″, 2″, 2½″, 3″—in 3/32″, ⅛″, 3/16″ thicknesses.

With the addition of the new miniature board, CTC *ALL-SET* Boards now cover the entire range of components.

All boards are of laminated phenolic, in five-section units, scribed for easy separation. Each section drilled for 14 lugs. Lugs solidly swaged into precise position . . . whole board ready for your assembly line.

SPECIAL PROBLEMS

Custom-built boards are a specialty with CTC. We're equipped to handle many types of materials including the latest types of glass laminates . . . many types of jobs requiring special tools . . . and all types of work to government specifications. Why not drop us a line about *your* problem? No obligation, of course.



Custom or Standard
The Guaranteed
Components

CAMBRIDGE THERMIONIC CORPORATION
456 Concord Avenue, Cambridge 38, Mass.

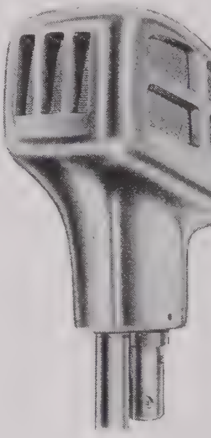
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 63A)

Studio Type Ribbon Microphone

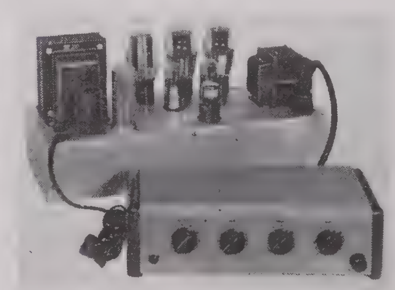
Amperite Co., Inc., 561 Broadway, New York 12, N. Y., has announced their new high-fidelity ribbon microphone for broadcast, sound recording, and quality public address applications. Covering 40 to 14,000 cps with an output of −56 dbm, it will find acceptance for use in existing studio speech input systems.



Its smooth response will avoid feedback troubles in public address uses, and the low distortion factor claimed by the maker, 1%, makes its use suitable in FM and video sound applications.

10 Watt All Triode Amplifier

Brook Electronics, Inc., 34 DeHart Place, Elizabeth, N. J. in response to many requests have commenced production on a low-powered model of their well-known all-triode amplifier, rated at a normal output of 10 watts, but capable of handling transients of much greater power with the low distortion percentages obtained from triode operation.



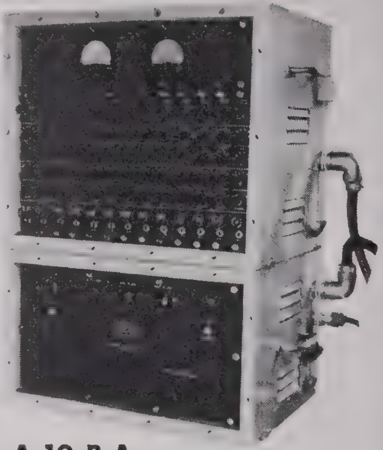
Two models are offered with the preamplifiers mounted remotely from the main amplifier chassis, or directly theron, according to the convenience of the user and his preference. In either case, full tone controls are incorporated, working through selector switches, to afford boost or attenuation at each end of the audio spectrum. Provision is included for a radio tuner and crystal or magnetic cartridge reproducers, with the proper equalization for the latter accessories, inbuilt within the amplifier.

(Continued on page 67A)

WATERMAN PRODUCTS

LINEAR AMPLIFIER

A-10-A-A



A-10-P-A

13 Channel Linear Amplifier has been specifically designed to operate low impedance type of galvanometer oscillographs. The output of the amplifier is 1.3 ohms, and full output voltage is 230 millivolts. The low output impedance and high output voltage permit loading down galvanometers of higher impedance, thus improving their frequency response. For example, if 40 ohm galvanometer with response up to 2KC be loaded down, the performance will be flat up to 5KC. The unit consists of A-10-A-A 13 channel amplifier, A-10-P-A power supply and A-10-C-A accessories (including cables, test jigs, etc.).

Each channel is a plug in unit containing all controls including metering. Spare units are available.

●

ALSO MANUFACTURERS OF

POCKETSCOPES
Model S-10-A
Model S-10-B
Model S-11-A

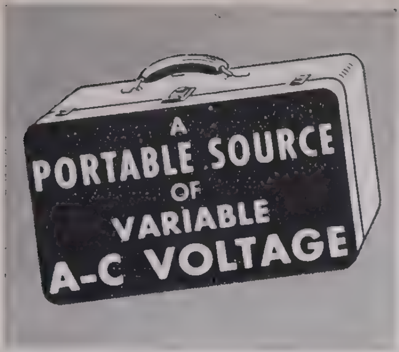
RACK MOUNTED OSCILLOSCOPES
Model S-12-A

3″ RAYONIC CATHODE RAY TUBE
Model 3MP1

RAYONIC CATHODE RAY TUBE ACCESSORIES
Model 3MP

For additional technical data on any of the above, please write:

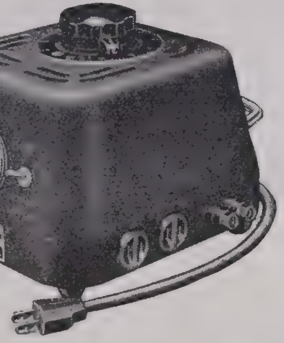
WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.



VOLTBOX
A-C POWER SUPPLY

- COMPACT
- PORTABLE
- HANDY

Operation of the Superior Electric VOLTBOX is simple. Plug into 50/60 cycle single phase source, snap "ON-OFF" switch to "ON". Snap "LINE-LOAD" switch to "LOAD", rotate knob to produce continuously adjustable output voltage, from 0 to 17 per cent above line voltage. Read line voltage by snapping "LINE-LOAD" switch to "LINE".



TYPE
UC1M

INPUT:	115 volts, 50/60 cycle, single phase
OUTPUT:	0-135 volts, 7.5 amperes, 1000 VA

Type UC2M available for 230 volt operation.

ALL THIS IN ONE PORTABLE PACKAGE

Cast aluminum case • POWERSTAT variable transformer • Easy-to-read voltmeter • Superior 5-Way Binding Posts • Output receptacles • "ON-OFF" switch • "LINE-LOAD" switch • Renewable fuse for overload protection • Six foot cord-plug.

FOR FULL DETAILS WRITE

THE
SUPERIOR ELECTRIC
COMPANY
811 MEADOW STREET
BRISTOL, CONN.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 64A)

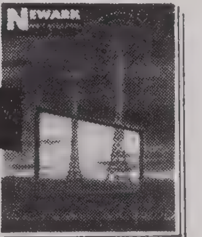
Equalized Pre-Amplifier for Magnetic Pick-Ups

Brociner Electronic Laboratories, 1546 Second Ave., New York 28, N. Y., has announced a new equalized preamplifier to adapt magnetic pickups to a useful output voltage. The three bass roll-over frequency adjustments and six treble attenuation positions afford a combination of eighteen variable transmission curves to suit the listening choice or record-wear conditions.

Small enough to mount on a 3½ inch panel, it will fit into most phonograph cabinets and transcription turntable mounts. A companion power supply is also available, small enough to mount on the same panel, which supplies direct current for both the filament heaters as well as the plates of the tubes. Broadcasting stations will find this unit of interest, because of its incorporation of a curve very close to the NAB-recommended playback characteristics.

free

1949
NEWARK
CATALOG



For EVERYONE interested in
TELEVISION • RADIO • ELECTRONICS
SOUND SYSTEMS • INDUSTRIAL EQUIPMENT
EVERYTHING in standard brand equipment!

Professionals! Radio Hams! Television Enthusiasts! Beginners! Oldtimers! Amateurs! Hobbyists! Here's one book that's a MUST for you! Our FREE 148 page catalog jammed with over 20,000 different items. The smallest part to the most complete industrial system from one dependable source!

24-HR. MAIL ORDER SERVICE • ONE YEAR TO PAY

3 GREAT STORES: Uptown at 115 West 45th St. and Downtown at 212 Fulton St. in NEW YORK
323 W. Madison St. in the heart of CHICAGO

MAIL ORDER DIVISIONS: 242 W. 55th St., N. Y. 19 and 323 West Madison St., Chicago 6, Illinois

NEWARK RADIO & TELEVISION

MAIL COUPON NOW

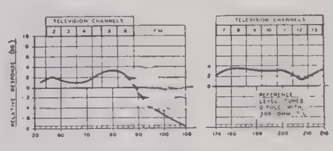
Newark Electric Co.
Dept. L-23, 242 W. 55th St.
New York 19 N. Y.

Please send me FREE the Newark 1949 Catalog
NAME____________________
ADDRESS____________CITY______STATE______

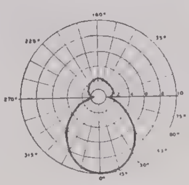
PREMAX

Tests Prove Best

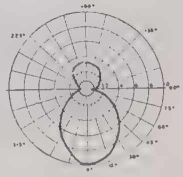
All-Channel Television Antenna



MEGACYCLES



Horizontal Directivity 60 mc.



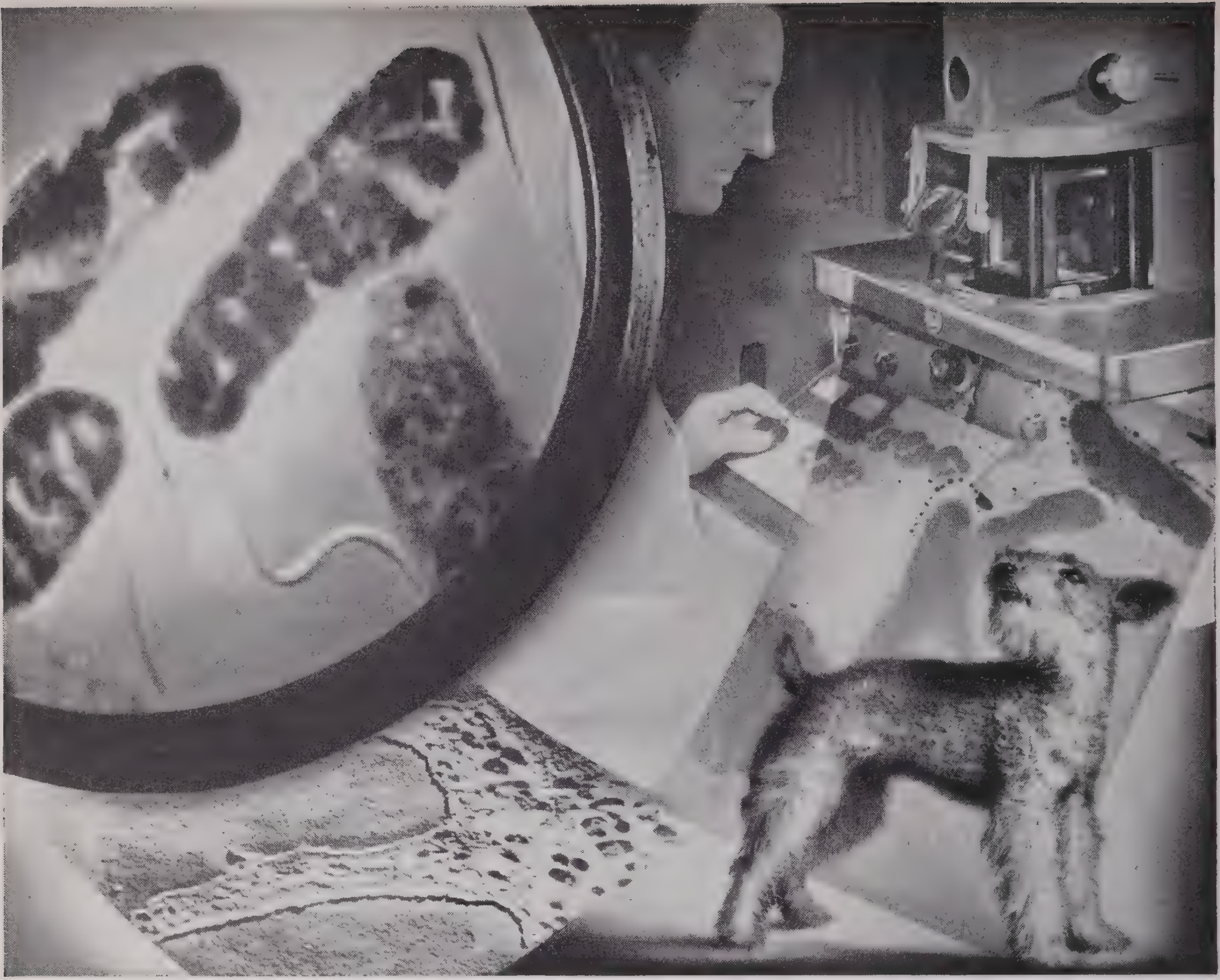
Horizontal Directivity 190 mc.

The Premax All-Channel Television Antenna No. T-448 consists of two fully adjustable arrays complete with reflectors—interconnected and licensed under AA&K Patents 2,282,292 and 2,422,458. Can be used as a 12-channel antenna or may be purchased separately for high or low frequency channels and later converted to an all-channel job.

It's simpler—lower in cost—easier to erect—has oversize elements and the famous adjustable V dipole design which permits adjustment in both vertical and horizontal planes.

List price $20. Send for test charts, full details and discount.

PREMAX PRODUCTS
DIVISION CHISHOLM-RYDER CO., INC.
4903 Highland Ave., Niagara Falls, N.Y.



Electron microscope, perfected at RCA Laboratories, reveals hitherto hidden facts about the structure of bacteria.

Bacteria bigger than a Terrier

Once scientists, exploring the invisible, worked relatively "blind." Few microscopes magnified more than 1500 diameters. Many bacteria, and almost all viruses, remained invisible.

Then RCA scientists opened new windows into a hidden world—with the first commercially practical electron microscope. In the laboratory this instrument has reached magnifications of 200,000 diameters and over. 100,000 is commonplace . . .

To understand such figures, picture this: A man magnified 200,000 times could lie with his head in Washington, D. C., and his feet in New York. . . . A hair similarly magnified would appear as large as the Washington monument.

Scientists not only see bacteria, but also viruses—and have even photographed a molecule! Specialists in other fields—such as industry, mining, agriculture, forestry—have learned unsuspected truths about natural resources.

Development of the electron microscope as a practical tool of science, medicine, and industry is another example of RCA research at work. This leadership is part of all instruments bearing the names RCA, and RCA Victor.

• • •

When in Radio City, New York, you are cordially invited to see the radio, television and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. Radio Corporation of America, RCA Building, Radio City, New York 20.

RADIO CORPORATION of AMERICA

Note to Broadcasters: Machlett Laboratories now produce for the Western Electric Company its line of high power transmitting tubes—so well known and respected by all broadcasting engineers. Made by Machlett Laboratories in close collaboration with Bell Telephone Laboratories, these tubes will continue to set the highest standard of performance in broadcast service. These tubes are distributed exclusively for Western Electric by the Graybar Electric Company in the U.S.A., and by the Northern Electric Company in Canada and Newfoundland.

This new combination of Western Electric and Machlett—two pioneers in the electron tube field—is your best assurance of progress and performance in the further development of better tubes to fill your needs.

Equipment designers, broadcasters, operators of point-to-point services, and industrial users of power tubes are invited to write for complete information. The Machlett Electron Tube Data Book will be sent on request.

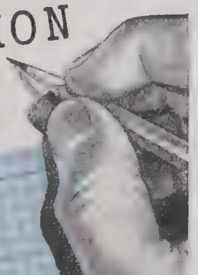
MACHLETT

Over 50 years
of Electron Tube Experience

MACHLETT LABORATORIES, INC.
Springdale, Connecticut

Write type BH6 into your design specifications!

BLILEY TYPE BH6 APPROVED FOR PRODUCTION



TECHNIQUALITY CRYSTALS

Engineered to the "MUST" requirements of current military and commercial communications

When you write Bliley Type BH6 into your specifications you meet all requirements, military or commercial . . . and you have simplified your design considerations by the elimination of unnecessary multiplier stages. Type BH6 is available up to 100 MC. Write us for oscillator circuit recommendations based on your particular requirements.

Bliley CRYSTALS

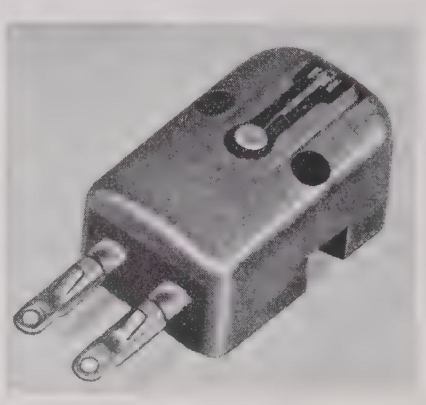
BLILEY ELECTRIC COMPANY
UNION STATION BLDG., ERIE, PA.

NEWS and NEW PRODUCTS

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Microgroove

This fall our industry has seen one outstanding development in the home entertainment field, that interests all engineers conscious of their need to keep abreast of the radio field. The vast amount of interest in those markets where it has been shown, has caused many firms to announce materials and accessories for the reproduction of the new long-playing Columbia Microgroove records. Changers, pick-ups, new cartridges, and similar accessories are flooding the market, not to overlook the adaptation of this feature to the completed sets offered the buying public. When far enough along in the development work Columbia records asked the co-operation of Philco to make a player attachment, with slow speed motor and light crystal cartridge equipped playing arm. Since then many other manufacturers have added these and other components to their lines.



General Electric, Electronics Division, Electronics Park, Syracuse, N. Y., who caused the largest stir in the phonograph-reproducer field, by the introduction about 18 months back, of their D1 RM 66 variable-reluctance cartridge, has entered the microgroove field with the announcement of the MICRO-GROOVE MODEL featuring a 1-mil-radius stylus, low mass of the moving system, and high compliance, to meet the requirements of the new records. Physically, the unit is one-third smaller than the predecessor model for standard records. All of the salient features such as quietness, absence of needle talk, long record life, etc., have been brought into this new design.

Gray Research & Development Co., 16 Arbor Street, Hartford 1, Conn., have introduced their version of the older GE cartridge, to which has been added a new moving system, of extreme lightness of mass, high tracking compliance, and proper stiffness, together with a diamond stylus of 1-mil radius to fit the shape of the new grooves. New damping blocks also have been fitted to Gray cartridge.

Webster-Chicago, 4245 N. Knox Ave., Chicago, Ill., has announced as available two models of a record changer capable of playing both 33 and 78 rpm records, equipped with a special needle in their "Tilt-o-Matic" tone arm. These changers play both types of records on an automatic or manual control basis, and afford the added advantage of disengaging the driving rubber idler wheels when in the off position, thus preventing the idlers from forming bumps or flats, and giving quieter operation.

Zenith Radio Corp., 6001 W. Dickens Avenue, Chicago 39, Ill., has announced that the console models of their fall line have microgroove feature added. Magnavox, and many more of the set makers have jumped aboard the bandwagon, to offer the buying public the means with which to play this latest development, in the home entertainment field.

Without philosophizing on the merits of this new offering, it is interesting to see the way in which manufacturing ingenuity and speed of production can accrue to fill a market readymade for it, when some enterprising firm takes it upon itself to pioneer a new product.

Recent Catalogs

National Co. 61 Sherman Street, Malden, Mass. announces a new television receiver, with 7″ tube, covering all 13 channels, scheduled for fall marketing. Techniques developed by this renowned company in stable communication receiver development find their way into the video sets they will offer. A novel innovation is the employment of dual 6″ oval loudspeakers flanking the video tube, for more realistic sound reproduction. Full particulars will be supplied for the asking.

Lenkurt Electric Co., 1129 County Road, San Carlos, California, announce a new catalogue comprising a comprehensive listing of the carrier-current telephone and telegraph equipment of their manufacture, form CX-42. In addition to the communication equipment described, ringing, dialing, and telemetering apparatus are covered, as well as selected test equipment, especially designed for operational servicing of carrier-current apparatus, is displayed and described. Comprehensive bulletins on each system are also available from the company.

Metalace Corp., 2101 Grand Concourse, New York 53, N. Y., have announced through a descriptive sheet their all-purpose antenna mounting base for affixing an antenna to a chimney or roof parapet. With the increased number of FM and video antennas finding their way to the rooftops of apartment houses and rural homes, such an accessory will lend itself readily to the safe and workmanlike installation of the antenna supporting pole. Simple tools alone are needed to make the installation, following the complete instructions furnished with the new stand.

(Continued on page 48A)

BRANIFF International AIRWAYS
BRANIFF

WILCOX

FIRST CHOICE OF

BRANIFF *International* AIRWAYS

BRANIFF EQUIPS GROUND STATIONS WITH WILCOX TYPE 364A TRANSMITTER

DESIGN SIMPLIFIES SERVICE

Conventional circuit design, fewer numbers and types of tubes, plus open mechanical construction simplify tube stocking problems and speed maintenance. The entire transmitter portion of the Type 364A is built on a drawer-type chassis, instantly withdrawable from the front of the panel.

RELAY RACK MOUNTING SAVES SPACE

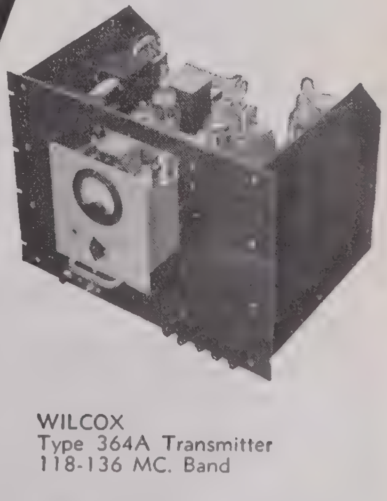
Compact design requires only 15 inches of rack space for installation, frequently utilizing space already available.

.005% FREQUENCY STABILITY WITHOUT TEMPERATURE CONTROL

Through the use of a newly developed crystal, troublesome thermostatic temperature controls and crystal ovens are no longer necessary to provide adequate frequency stability.

SIMPLIFIED CONTROL FOR REMOTE LOCATION

Modulation over a single telephone pair and carrier control by means of a simplex circuit allow the transmitter to be readily located at a remote point.



WILCOX
Type 364A Transmitter
118-136 MC. Band

WILCOX
ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI

Write Today . . . for
Complete Information

3 Outstanding

COSMALITE*
COIL FORMS

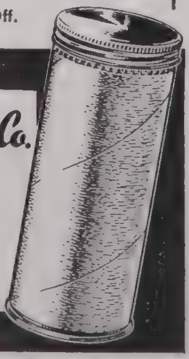
Each specially designed and produced by us to give exceptional performance, and at a saving in cost to this country's leading manufacturers of radio and television receivers.

Your specifications as to punching, threading, notching and grooving are followed with the most exacting care. Ask about our many stock punching dies available to you.

Are you familiar with our #96 COSMALITE for coil forms in all standard broadcast receiving sets; SLF COSMALITE for permeability tuners; COSMALITE deflection yoke shells, cores and rings?

Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

*Reg. U.S. Pat. Off.



The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO
- All-Fibre Cans • Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

PRODUCTION PLANTS also at Plymouth, Wisc., Ogdensburg, N.Y., Chicago, Ill., Detroit, Mich., Jamesburg, N.J.
PLASTICS DIVISION at Plymouth, Wisc. • ABRASIVE DIVISION at Cleveland, Ohio
SALES OFFICES: Room 5632, Grand Central Term. Bldg., New York 17, N.Y., also 647 Main St., Hartford, Conn.
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario

SECTION MEETINGS

ATLANTA

"Railroad Radio Communication Equipment," by H. B. Hildreth, Central of Georgia Railroad; June 25, 1948.

"Installation and Equipment of WSB New TV Station," by C. F. Daugherty, Station WSB; September 17, 1948.

BALTIMORE

"Columbia Long-Playing Microgroove Recording System," by P. C. Goldmark, Columbia Broadcasting Company; September 28, 1948.

BUFFALO-NIAGARA

"Horizontal Deflection and High Voltage in Television Receivers," by H. R. Shaw, Colonial Radio Corporation; September 15, 1948.

CLEVELAND

"Television Studio Lighting," by R. Blount, General Electric Company; September 23, 1948.

DALLAS-FORT WORTH

"Some Problems of Television," by B. E. Shackelford, President, The Institute of Radio Engineers; October 11, 1948.

HOUSTON

"Printed Circuits, Subminiature Radio Transmitters, and Receivers," by C. Brunetti, National Bureau of Standards; September 20, 1948.

"Recent Developments in Semi-Conductors and the Transitor," by J. A. Becker, Bell Telephone Laboratory; September 20, 1948.

"Basic and General Problems of Television as a Service," by B. E. Shackelford, President, The Institute of Radio Engineers; October 8, 1948.

KANSAS CITY

"Magnetic Recording," by C. G. Barker, Magnecord, Inc.; September 20, 1948.

NEW MEXICO

"Some Problems of Teleivision," by B. E. Shackelford, President, The Institute of Radio Engineers; October 5, 1948.

NORTH CAROLINA-VIRGINIA

"Detection by Heat Radiation," by N. C. Jamison, Phillips Laboratories; May 14, 1948.

"Electronic Computers," by C. N. Hoyler, Radio Corporation of America; September 10, 1948.

PHILADELPHIA

"A New Long-Playing Disk Recording System," by P. C. Goldmark, Columbia Broadcasting Company; October 7, 1948.

ST. LOUIS

"Sound Level Measurements," by J. L. Glaser, Washington University; September 23, 1948.

SAN ANTONIO

"Radar Reflections from the Lower Atmosphere," by W. E. Gordon, University of Texas; May 26, 1948.

"The Electron Microscope," by L. L. Antes, University of Texas; June 24, 1948.

SAN FRANCISCO

"The Measurement of Faint Light by Photoelectric Methods," by G. E. Kron, Lick Observatory; September 8, 1948.

SEATTLE

"Cathode-Ray Sweep Circuits," by M. A. Starr, University of Portland; June 11, 1948.

"Problems in Development of Television," by B. E. Shackelford, President, The Institute of Radio Engineers; September 24, 1948.

(Continued on page 37A)

SECTION MEETINGS

(Continued from page 34A)

Syracuse

"Nuclear Power Production," by H. Stevens, General Electric Company; October 7, 1948.

Toledo

"Microwave Communication," by J. W. McRae, Bell Telephone Laboratories, Inc.; September 16, 1948.

Toronto

"The Design and Installation of a 5-Kw High-Channel Television Transmitter," by R. E. Fisk, General Electric Company; October 4, 1948.

Twin Cities

"Television—Its Mechanism and Promise," by W. Lawrence, Radio Corporation of America; September 21, 1948.

Washington

"Magnetic Tape Recording," by R. H. Ranger, Rangertone, Inc.; September 20, 1948.

SUB-SECTIONS

Northern New Jersey

"The WATV Television Station," by T. M. Gluyas, Radio Corporation of America, and F. Bremer, Bremer Broadcasting Company; September 15, 1948.

STUDENT BRANCH MEETINGS

University of Arizona—IRE-AIEE Branch

Election of Officers; September 15, 1948.

"Grand Coulee Power Project," by J. H. Pfeiffer, Student, University of Arizona; October 6, 1948.

University of California—IRE-AIEE Branch

"The Engineering Industry Looks at the College Graduate," by M. P. O'Brien, University of California; October 5, 1948.

"Advantages of Membership in a Professional Society," by J. R. Whinnery, University of California; October 5, 1948.

"The Plans for the New Electrical Engineering Building," by T. C. McFarland, University of California; October 5, 1948.

Carnegie Institute of Technology—IRE-AIEE Branch

"Carnegie Tech Cyclotron," by H. E. DeBolt and L. Johnson, Graduate Students, Carnegie Institute of Technology; October 11, 1948.

City College of New York—IRE Branch

"Student Activity in the Institute of Radio Engineers," by E. K. Gannett, The Institute of Radio Engineers; September 28, 1948.

"Co-ordination of Student Branches in the Metropolitan Area," by S. G. Lutz, New York University; September 28, 1948.

University of Florida—IRE-AIEE Branch

"Our Institute," by E. S. Lee, President, AIEE; September 29, 1948.

(Continued on page 38A)

An Important Statement

by

MYCALEX

CORPORATION OF AMERICA

As illustrated on the opposite page, PHILCO uses Mycalex 410 (glass bonded mica) molded parts in its television receiver tuner—to avoid frequency drift of tuned circuits.

Your attention is also called to the Mycalex 410 advertisement which appeared on pages 30 and 31 of the October 1948 issue of Proc. of I.R.E.

Constant research, improved technics, advances in the art, new, modern plant expansion, improved engineering, more efficient manufacturing equipment—now permit us to make available in increased quantities—Mycalex 410—molded—*at prices comparable* to other less efficient molded insulations.

MYCALEX 410 is now priced to meet rigid economy requirements

Any interest evidenced on your part in Mycalex products and services—will receive the prompt, courteous and intelligent attention of a competent Mycalex sales engineer. He will receive the fullest backing and cooperation from other factory executives—to serve you promptly—with a quality product and at an economical and fair price.

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

Engineered to the Highest FM and AM Broadcast Standards

NEW!

High Fidelity Dynamic

E-V BROADCAST Microphones

Model 650
(Output −46 db)

FEATURES LIKE THESE
WIN *TOP RATING*
by Station and Network Engineers!

Flat out to 15 kc! Extremely high output! Impedance selector! Dual-type shock-mount! Remarkably rugged! Individually calibrated!

Developed in cooperation with station and network engineers, the new "650" and "645" meet exacting requirements of modern high fidelity FM and AM broadcast service. Proved in studio and remote use. Polar pattern is non-directional at low frequencies, becoming directional at high frequencies. Recessed switch gives instant selection of 50 or 250 ohms impedance. Exclusive Acoustalloy diaphragm withstands toughest use. Many other important features assure the ultimate in broadcast quality. Satin chromium finish. Fully guaranteed.

Model 650. Output level —46 db. List **$150.00**
Model 645. Output level —50 db. List **$100.00**

Broadcast Engineers: Put the "650" or "645" to the test in your station. Know the thrill of using the newest and finest. Write for full details.

NO FINER CHOICE THAN

Electro-Voice

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN
Export: 13 East 40th St., New York 16, U.S.A. Cables: Arlab

Model 645
(Output −50 db)

STUDENT BRANCH MEETINGS

(Continued from page 37A)

IOWA STATE COLLEGE—IRE-AIEE BRANCH

"Registration of Engineers," by J. S. Dodds, Iowa State College; September 29, 1948.

STATE UNIVERSITY OF IOWA—IRE-AIEE BRANCH

"Radio Station WMT—Electrolysis Transmission Lines," by J. A. O'Brien and D. A. McMillon, October 13, 1948.

NEW YORK UNIVERSITY—IRE BRANCH

"Electrical Analogues of Acoustical Speakers," by C. Rehberg, New York University; October 14, 1948.

NORTH CAROLINA STATE COLLEGE—IRE BRANCH

"High-Fidelity Reproduction of Sound," by D. K. Briggs, Western Electric Company; September 29, 1948.

UNIVERSITY OF NORTH DAKOTA—
IRE-AIEE BRANCH

Election of Officers; September 29, 1948.

PRATT INSTITUTE—IRE BRANCH

"Cathode Follower," by W. Heacock, Student, Pratt Institute; October 7, 1948.

STANFORD UNIVERSITY—IRE-AIEE BRANCH

"Industrial Research Today," by J. E. Hobson, Stanford Research Institute; October 6, 1948.

UNIVERSITY OF TENNESSEE—IRE BRANCH

"Dimensional Analysis," by J. D. Tillman, Faculty of University of Tennessee; October 5, 1948.

WAYNE UNIVERSITY—IRE-AIEE BRANCH

"Student Papers," by E. Spring, Wayne University; October 7, 1948.

UNIVERSITY OF WISCONSIN—IRE BRANCH

"Job Opportunities and How to be Properly Interviewed," by H. Goehring, University of Wisconsin; October 5, 1948.

WORCESTER POLYTECHNIC INSTITUTE—
IRE-AIEE BRANCH

"Frequency Modulation," by G. E. Stannard, Worcester Polytechnic Institute; October 7, 1948.

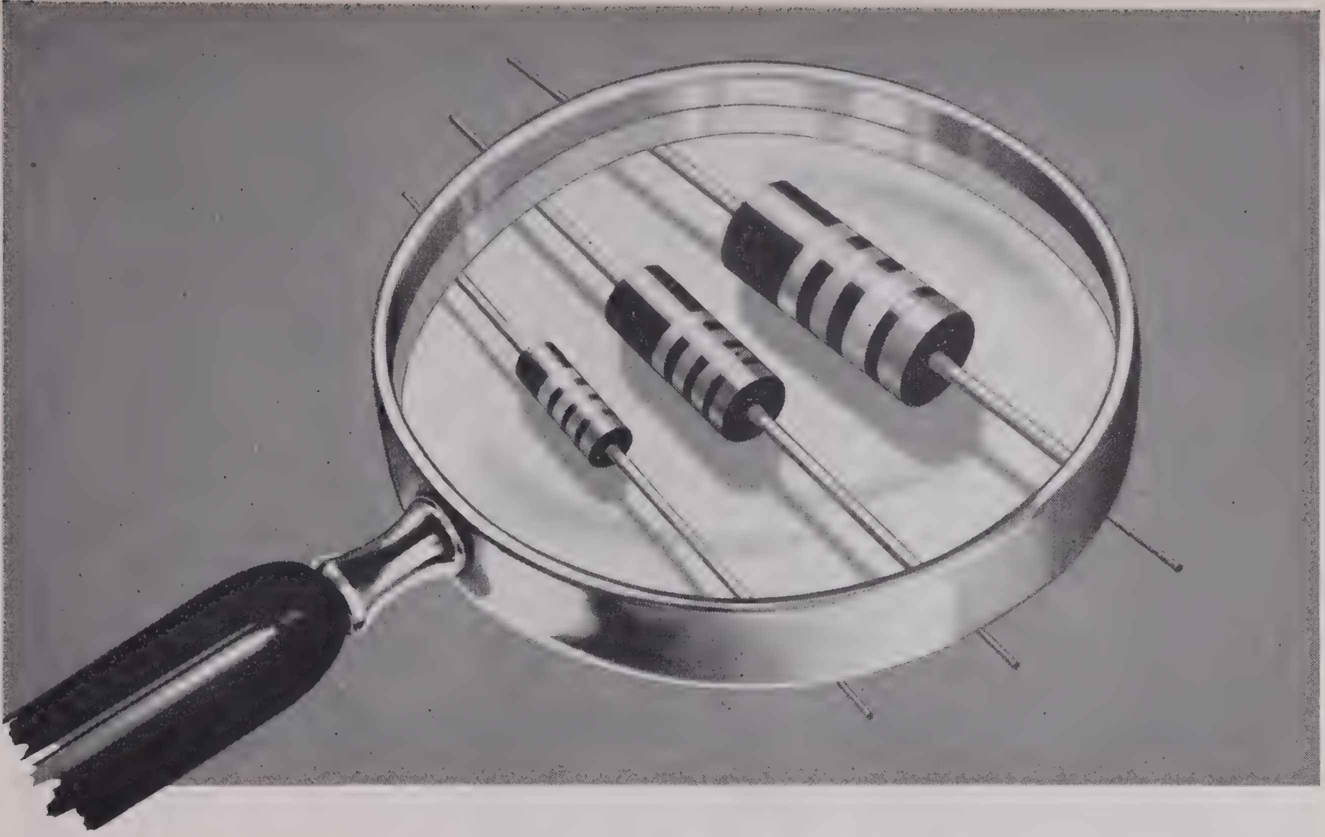
MEMBERSHIP

The following transfers and admissions were approved to be effective as of December 1, 1948:

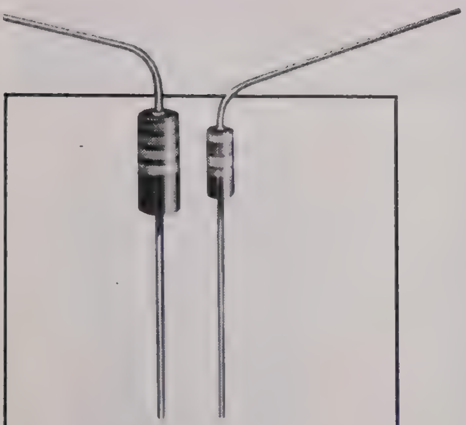
Transfer to Senior Member

Batchelor, J. C., 31 Sheldon Pl., Hastings-on-Hudson, N. Y.
Beggs, G. E., Jr., School Lane, Warrington, Pa.
Brewer, A. F., 11605 Crenshaw Blvd., Inglewood, Calif.
Cerrillo, M. V., Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Mass.
Cornes, R. W., 231 Northern Pkwy., East Hempstead, L. I., N. Y.
Sievert, A. H., Canadian Westinghouse Co., Ltd., Hamilton, Ont., Canada
Sobel, A. D., 2939 Ocean Ave., Brooklyn, N. Y. (November 1, 1948.)

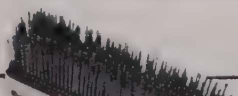
(Continued on page 40A)



BRADLEYUNITS



SIZES OF UNITS		
Rating	L	D
½-w	3/8″	9/64″
1-w	9/16″	7/32″
2-w	11/16″	5/16″



Packed in convenient honeycomb cartons for quicker assembly.

½ WATT • 1 WATT • 2 WATT
Small in Size • Big in Wattage

Bradleyunits are so small for their ratings that we can't picture their exceptional capacity . . . without magnifying them. So here they are . . . available in all standard R.M.A. values, as follows:

½-watt rating—10.0 ohms to 22 megohms
1-watt rating— 2.7 ohms to 22 megohms
2-watt rating—10.0 ohms to 22 megohms

Bradleyunits will operate at full rating for 1000 hours at 70 C ambient temperature with a resistance change of less than 5%. They require no wax impregnation to pass salt-water immersion tests and have high mechanical strength and permanent characteristics. Let us send you a complete Allen-Bradley resistor chart.

Allen-Bradley Co., 114 W. Greenfield Ave., Milwaukee 4, Wis.

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

Standardize on One
CAATC
1R2-1

Now, one crystal unit will accommodate all aircraft communications equipment applications. The RH-7B-68 crystal unit is available for commercial airline radio over a frequency range of 1 to 75 mc. This unit, too, can be made to Army-Navy specifications or to fit your particular application. Why not standardize now, on one!

For complete information write for Bulletin RHC-X

REEVES-HOFFMAN
CORPORATION
CHERRY AND NORTH STREETS • CARLISLE, PA.

MEMBERSHIP

(Continued from page 38A)

Admission to Senior Member

Jones, T. F., Jr., 41 Atherton St., Roxbury, Mass.
Mayberry, L. A., The Hallicrafters Co., 4401 W. Fifth Ave., Chicago, Ill. (November 1, 1948.)
Sinninger, D. V., 2662 W. Jarlath Ave., Chicago, Ill.

Transfer to Member

Abbott, S. L., 1929 Davidson Ave., New York, N. Y.
Arand, E. M., 3125 N. Emerson St., Franklin Park, Ill.
Cameron, E. G., 10 Randolph Pl., Verona, N. J.
College, C. H., 11 Duvall Dr., W. Moreland Hills, Washington, D. C.
Goodman, P. D., Scott Laboratory, Wesleyan University, Middletown, Conn.
Houghton, R. W., Foster St., Littleton, Mass.
Moulton, A. B., 2534—24 St., N., Arlington, Va.
Newburgh, H., 610 W. Nittany Ave., State College, Pa.
Raycer, P. M., 333 E. 69 St., New York, N. Y.
Seaton, J. W., 3430—39 St., N.W., Washington, D.C.
Shapiro, O., 7 Sunset Dr., E., Nutley, N. J.
Smith, E. K., Jr., 4313 Ninth Ave., Brooklyn, N. Y.
Taylor, R. S., 2012 N. Upland St., Arlington, Va.
Toye, J. M., 51 St. Clair Ave., Toronto, Ont., Canada
Woster, G. W., 3018 W. 51 Ter., Kansas City, Kan.

Admission to Member Grade

Benson, K. B., Harbor View, South Norwalk, Conn.
Bobb, L. J., The International Electronics Co., 808 N. Broad St., Philadelphia, Pa.
Bose, K. K., 28/1/3 Gariahat Rd., Calcutta, P.O. Ballygunge, India
Corner, K. T., 108 North Ave. 19, Los Angeles, Calif.
Coullard, J. B., 111 Hazelhurst Ave., R.F.D. 1, North Syracuse, N. Y.
Field, L. M., 695 Columbia St., Palo Alto, Calif.
Gray, H. F., Jr., 21 Studio Lane, Bronxville, N. Y.
Green, J. R., 535 W. 110 St., New York, N. Y.
Johnston, O. B., 1012 E. 35 St., Minneapolis, Minn.
Jones, L. M., 1092 Beverly Way, Altadena, Calif.
Kerawalla, R. D., 6 Elsham Rd., London W. 14, England
Ralston, G., Apt. 201, 607 Hay St., Wilkinsburg, Pa.
Ray, H. B., 223 Newcomb St., S.E., Washington, D. C.
Riggin, J. D., Box 11, Del Monte, Calif.
Rooney, J. D., Box 3, ComServPac Staff, c/o FPO, San Francisco, Calif.
Schultz, C. W., R.F.D. 2, Storrs, Conn.
Shannon, C. E., Bell Telephone Laboratories, Murray Hill, N. J.
Tosh, W. M., c/o Electronics Institute Inc., 21 Henry St., Detroit, Mich.
Widerquist, V. R., SEES, Georgia Institute of Technology, 225 North Ave., N.W., Atlanta, Ga.

The following admissions to Associate grade have been approved and were effective as of November 1, 1948:

Ainsworth, M. G., 4803 Cornelia, Chicago 41, Ill.
Allen, J. R., 746 W. 104 Pl., Los Angeles 44, Calif.
Alpert, N., 55 E. Mosholu Pkwy., N., New York 67, N. Y.
Backstrand, W. C., c/o Physics Department, Whitman College, Walla Walla, Wash.
Barnes, A. W., 1917 Virginia, Berkeley 9, Calif.
Beaumont, G. F., 91 Charlton Ave., W., Hamilton, Ont., Canada
Berry, R. M., 2307 Cascade Trail, Bremerton, Wash.

(Continued on page 42A)

FREED

"PRODUCTS of EXTENSIVE RESEARCH"

No. 1030 by Freed

No. 1110 by Freed

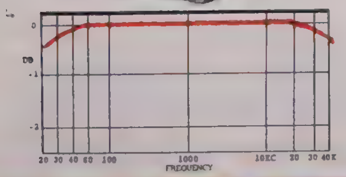
"Q" INDICATOR

Frequency range from 20 cycles to 50 kilocycles. "Q" range from .5 to 500.
"Q" of inductors can be measured with up to 50 volts across the coil. Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dielectric losses, and power factor of insulating materials.

INCREMENTAL INDUCTANCE BRIDGE

IMPEDANCE RANGE: One millihenry to 1000 henries in five ranges. Inductance values are read directly from a four dial decade and multiplier switch. This range can be extended to 10,000 henries by the use of an external resistance.
INDUCTANCE ACCURACY: Within plus or minus 1% through the frequency range from 60 to 1000 cycles.

A NEW LINE OF HIGH FIDELITY OUTPUT TRANSFORMERS



Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	± ½db from	Maximum level
F1950	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

FREED TRANSFORMER CO., INC.

DEPT. PD **1718-36 WEIRFIELD ST.,** **BROOKLYN 27, NEW YORK**

AN ENTIRELY NEW
Dependable
AUTOMATIC DEHYDRATOR
BY
Andrew

For pressurizing coaxial systems with dry air

WRITE FOR BULLETIN 85

Now, for the first time, here is an automatic dehydrator that operates at line pressure! This means, (1) longer life, and (2) less maintenance and replacement cost than any other automatic dehydrator.

Longer life because the compressor diaphragm operates at only 1/3 the pressure used in comparable units, vastly increasing the life of this vulnerable key part.

Reduced maintenance and replacement costs because new low pressure design eliminates many components.

Operation is completely automatic. Dehydrator delivers dry air to line when pressure drops to 10 PSI and stops when pressure reaches 15 PSI. After a total of 4 hours' running time on intermittent operation, the dry air supply is turned off and reactivation begins, continuing for 2 consecutive hours. Absorbed moisture is driven off as steam. Indicators show at a glance which operation the dehydrator is currently performing.

Output is 1¼ cubic feet per minute, enough to serve 700 feet of 6⅛" line; 2500 feet of 3⅛" line; 10,000 feet of 1⅝" line or 40,000 feet of ⅞" line. Installation is simple, requiring only a few moments.

Important! Not only is this new differently designed Andrew Automatic Dehydrator completely reliable, but it is available at a surprisingly low price.

Andrew
CORPORATION
363 E. 75th STREET, CHICAGO 19
Eastern Office:
421 Seventh Avenue, New York City

ANDREW

TRANSMISSION LINES FOR AM, FM, TV. DIRECTIONAL ANTENNA EQUIPMENT, ANTENNA TUNING UNITS, TOWER LIGHTING EQUIPMENT, CONSULTING ENGINEERING SERVICE.

MAIL COUPON NOW!

MAIL COUPON NOW!

ANDREW CORPORATION, 363 E. 75th St., Chicago 19
Please send me Bulletin 85 describing the new Type 1900 Andrew Automatic Dehydrator.

Name____________________
Title____________________
Company____________________
Address____________________
City__________Zone____State________
IRE 12-48

MEMBERSHIP

(Continued from page 40A)

Beymer, E. H., 605 B. Anacada Dr., Oxnard, Calif.
Bluhm, R. W., 32 Woodcrest Ave., Short Hills, N. J.
Bombe, A. A., 29-01—159 St., Flushing, L. I., N. Y.
Browning, C. L., 3617 Montrose Blvd., Houston 6, Tex.
Brown, T. J., 1542 Marine Dr., W. Vancouver, B. C., Canada
Burgess, H. R. C., 2621 Laguna St., San Francisco 23, Calif.
Byers, A. E., 50 North Broadway, White Plains, N. Y.
Carney, J. J., Y.M.C.A., 117 W. Monument St., Dayton 2, Ohio
Chamberlain, E., 102 Woodlands Rd., Hull, E. Yorks, England
Chapin, E. L., Jr., 4711 W. Main St., Belleville, Ill.
Chase, W., Barnard Hall, North Brother Island, New York 54, N. Y.
Clark, L. G., 6227—21, N.E., Seattle 5, Wash.
Corbett, H. L., 124½ Percy St., Ottawa, Ont., Canada
Daleo, S. L., 198 First Ave., New York 3, N. Y.
DeVoe, W. D., 3312 Technical Training Squadron, Officers Comm., Scott Field, Belleville, Ill.
Douglas, M. D., 76 Concord Rd., R.F.D. 3, Chagrin Falls, Ohio
Dunlap, R. H., 408 Baltimore, San Antonio, Tex.
Edwards, M. J., R.F.D. 3, Box 483, Glendale, Ariz.
Eisner, W. K., 486 Ashford St., Brooklyn, N. Y.
Elikann, L. S., 1439 East 19 St., Brooklyn, N. Y.
Favreau, R. R., 6765 W. 86 Pl., Los Angeles 45, Calif.
Fielding, B. L., 5019½ Lankershim Blvd., North Hollywood, Calif.
Fisher, S., 11 Westcott Rd., Princeton, N. J.
Froke, L. C., Radio Station KELO, Sioux Falls, S. Dak.
Gold, M., 254 Fountain Ave., Dayton, Ohio
Goldstein, I., 80 Brantwood Rd., Worcester, Mass.
Gones, R. D., 4568 Mary Ave., St. Louis 7, Mo.
Gudaitis, W. V., 1617 Morrell, Detroit 9, Mich.
Harpole, J. L., Live Oak Plant, Ravenel S. C.
Holmquist W. L. 116 E. Park Ave., Libertyville, Ill.
Horn, R. H., 1370 Washington St., San Francisco 9, Calif.
Jones, H. G., 3776 Milan St., San Diego 7, Calif.
Jorgensen, S. W., 88-36—187 St., Hollis 7, L. I., N. Y.
Kasparek, J. J., 309 N. Wayne St., Angola, Ind.
Kliopera, M. F., 3221 Charleston Circle, Houston 4, Tex.
Kreis, R. J., Box 97, College Park, Md.
Lanwell, L. W., 313½ Main Ave., McCook, Neb.
Lapidos, R. W., 134 Penn Ave., Collingswood, N. J.
Larsen, N. J., Radio Station KMMJ, Grand Island, Neb.
Lauterbach, R. E., 845 S. Williams St., Denver 9, Col.
Lidz, S., 451 Washington Ave., Brooklyn 5, N. Y.
Munn, E. H., Jr., 306 N. West St., Hillsdale, Mich.
Olander, R. O., 64 Homestead Ave., Bridgeport 3, Conn.
Osteyee, W. W., QTRS, 349 Doniphan, Fort Bliss, Tex.
Ott, L. O., 220 S. Kenwood St., Glendale 5, Calif.
Parode, L. C., 711 Stepney St., Inglewood, Calif.
Pellock, J., 10745 Channock Rd., Los Angeles, Calif.
Petit, F. W., North Woodbury, Conn.
Prabhu, K. S., Department of Communication Engineering, Indian Institute of Science, Bangalore 3, India
Pritchett, W. C., 400 E. 32, Austin, Tex.

(Continued on page 46A)

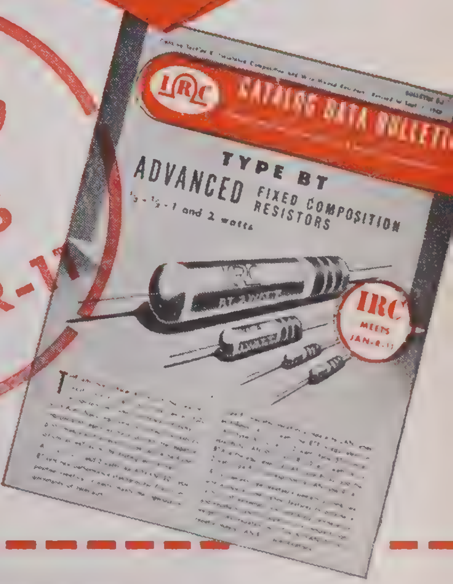
BT resistor will change your standards of performance for fixed composition resistors

Get the full performance facts on this ADVANCED resistor

Standards for resistor performance set by this *new* IRC Type BT are so advanced, you need complete information to fully evaluate its significance. Test result charts will show you how this *advanced* resistor easily performs the rigorous requirements of television. Performance curves prove its excellence in every characteristic . . . particularly in high ambient temperatures.

Technical Data Bulletin B-1 gives the full story. We shall be glad to rush it to your desk or drawing board . . . or to have our representative review your requirements in the light of this *advanced* resistor. Use the handy coupon below.

IRC MEETS JAN-R-11


IRC CATALOG DATA BULLETIN
TYPE BT
ADVANCED FIXED COMPOSITION RESISTORS
½ - ½ - 1 and 2 watts
IRC MEETS JAN-R-11

IRC

power resistors • precisions • insulated composition resistors • low wattage wire wounds • rheostats • controls • voltmeter multipliers • voltage dividers • HF and high voltage resistors.

INTERNATIONAL RESISTANCE CO., 401 N. Broad Street, Philadelphia 8, Pa.
IN CANADA: *International Resistance Co., LTD., Toronto, Licensee*

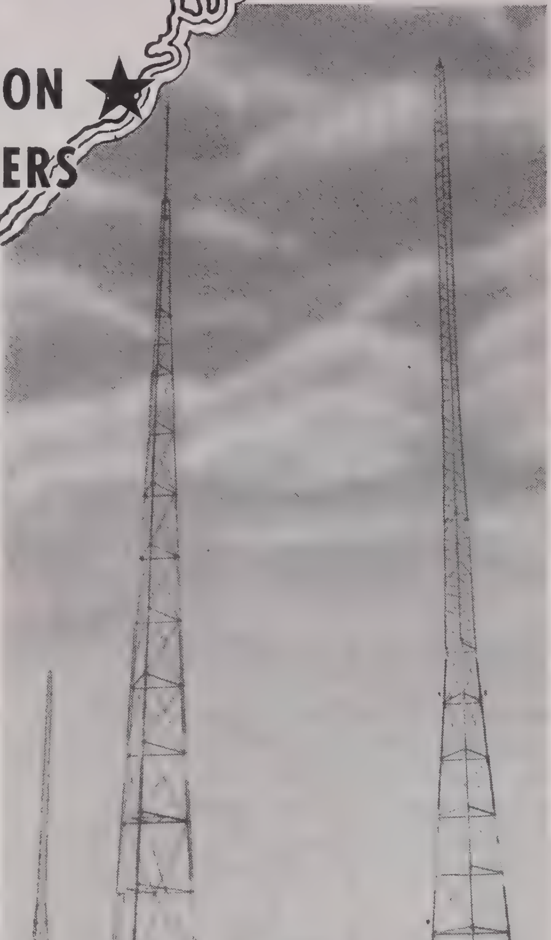
etter Test Results BT means Better Television

International Resistance Co.
401 N. Broad St., Phila. 8, Pa.

I want to know more about IRC's *advanced* BT Resistor:

☐ Send me Technical Data Bulletin B-1.
☐ Have your representative call—no obligation.

Name ....
Title ....
Company ....
Address ....
....



WCSC faithfully serves the Charleston, S.C. area with TRUSCON RADIO TOWERS

Radio Station WCSC, Charleston, S. C. uses two Type B, 190 ft., Truscon Radio Towers, and one Type D-30, 313 ft., Truscon Radio Tower with 8-unit W.E. Cloverleaf FM.

WCSC transmits its 5,000 watt regional channel AM signal from three Truscon Self-Supporting Radio Towers—two of these being 190 feet high and the third hoisting an 8-unit WE Cloverleaf antenna 354 feet into the South Carolina sky, to serve Charleston's FM needs.

Like every Truscon Radio Tower installation, this WCSC set-up is engineered for its specific job and location. Truscon can design and manufacture any type of tower you need—guyed or self-supporting . . . tapered or uniform cross-section . . . tall or small . . . AM, FM or TV.

Your letter or phone call to Truscon, Youngstown, Ohio, or to any convenient district office, will bring you prompt engineering consultation. No obligation, of course.

TRUSCON STEEL COMPANY

Subsidiary of Republic Steel Corporation • YOUNGSTOWN 1, OHIO

TRUSCON SELF-SUPPORTING AND UNIFORM CROSS SECTION GUYED TOWERS

MEMBERSHIP

(Continued from page 42A)

Rapp, R. M., 8 Kinmore St., Warren, Pa.
Rasmussen, C. F., 201 West 90 St., Los Angeles, Calif.
Rayasa, N. G., Nagappa Block 1321 Sreerampur, Bangalore 3, India
Rayasa, R. G., c/o Radio Sonde Section, Observatory, Lodi Rd., New Delhi, India
Reeves, E. H., 200 Franklin St., Bloomfield, N. J.
Robey, R. E., 142-36—32 Ave., Flushing, L. I., N. Y.
Robinson, R. J., 326 Chicopee St., Chicopee, Mass.
Rogers, J. B., 449 Highbrook Ave., Pelham Manor, N. Y.
Seshadri, K. V., c/o Prof. K. Sreenivasan, Department of Electric Communication Engineering, Indian Institute of Science, Bangalore 3, India
Seybold, J. F., 3278 West 44 St., Cleveland 9, Ohio
Shaw, H. H., 1811 Roberta Ave., Willow Grove, Pa.
Smith, J. D., 3220 Duval St., Houston, Tex.
Soorin, A. J., R.F.D. 1, Box 20, Long Branch, N. J.
Srinivasan, L. S., c/o Rao Bahdur T.V.V. Aiyer, Conservator of Forests, Thycaud, Trivandrum, India
Steen, P. W., 2 Matthew Lane, Buffalo 21, N. Y.
Stewart, G. L., 194 Colbeck St., Toronto, Ont., Canada
Tariot, J. N., 1 Highland St., Cambridge 38, Mass.
Theurer, D. L., 900 W. Maumee St., Angola, Ind.
Thomson, R. D., 510 E. Wynnewood Rd., Wynnewood, Pa.
Tims, E. F., Louisiana State University, Electrical Engineering Department, Baton Rouge 3, La.
Triplett, T. R., 18 Chauncey St., Apt. 6, Cambridge 38, Mass.
Tuksal, M. A., 3053 W. Grand Blvd., Detroit 2, Mich.
Warwick, J. D., 25 Marathon Ave., Dayton 5, Ohio
Weinberg, M. D., 81 Ocean Pkwy., Brooklyn 18, N. Y.
Whelchel, G. O., Jr., 531 Stinard Ave., Syracuse, N. Y.
Whitman, K. W., 5752 Seventh Ave., Los Angeles 43, Calif.

The following transfers to Associate grade were approved to be effective as of November 1, 1948:

Cassutt, R. J., 1811 Chandler St., S.W., Cedar Rapids, Iowa
Dimasi, L. A., 641 Highland Ave., Greensburg, Pa.
Giloth, P. K., 2515 Ashland Ave., Evanston, Ill.
Goodill, J. J., 544 East 7 St., Erie, Pa.
Hooper, W. D., 1103 S. University, Ann Arbor, Mich.
Irons H. R., 7929 Georgia Ave., Silver Spring, Md.
Kazanowski, H. F., 228 Winchester St., Brookline, Mass.
Lewis, F. C., 336 S. Market St., Galion, Ohio
Licata, J. P., 1063 Forest Rd., Schenectady, N. Y.
Lipin, B., 4142 Paseo, Kansas City 4, Mo.
Lovell, J. A., 5 Croyden Rd., Mineola, L. I., N. Y.
Meyer, J. A., Box 2018, University of Arkansas, Fayetteville, Ark.
Panetta, A. R., 1865 East 81 St., Cleveland 3, Ohio
Ross, D. O., 88 Percival Ave., Montreal West, Que., Canada
Sabol, R. W., 17 S. Oxford St., Brooklyn 17, N. Y.
Slagter, H. C., 47 Lincoln St., Pittsfield, Mass.
Spielberger, S. C., 90-28—148 St., Jamaica 2, N. Y.
Wall, V. W., 253 Elmwood Ave., Maplewood, N. J.
Wolff, J. L., Jr., R.F.D. 4, Greensburg, Pa.
Wright, J. R., 9600 St. Lawrence Blvd., Montreal, Que., Canada
Yard, R. R., 1 West 68 St., New York 23, N. Y.

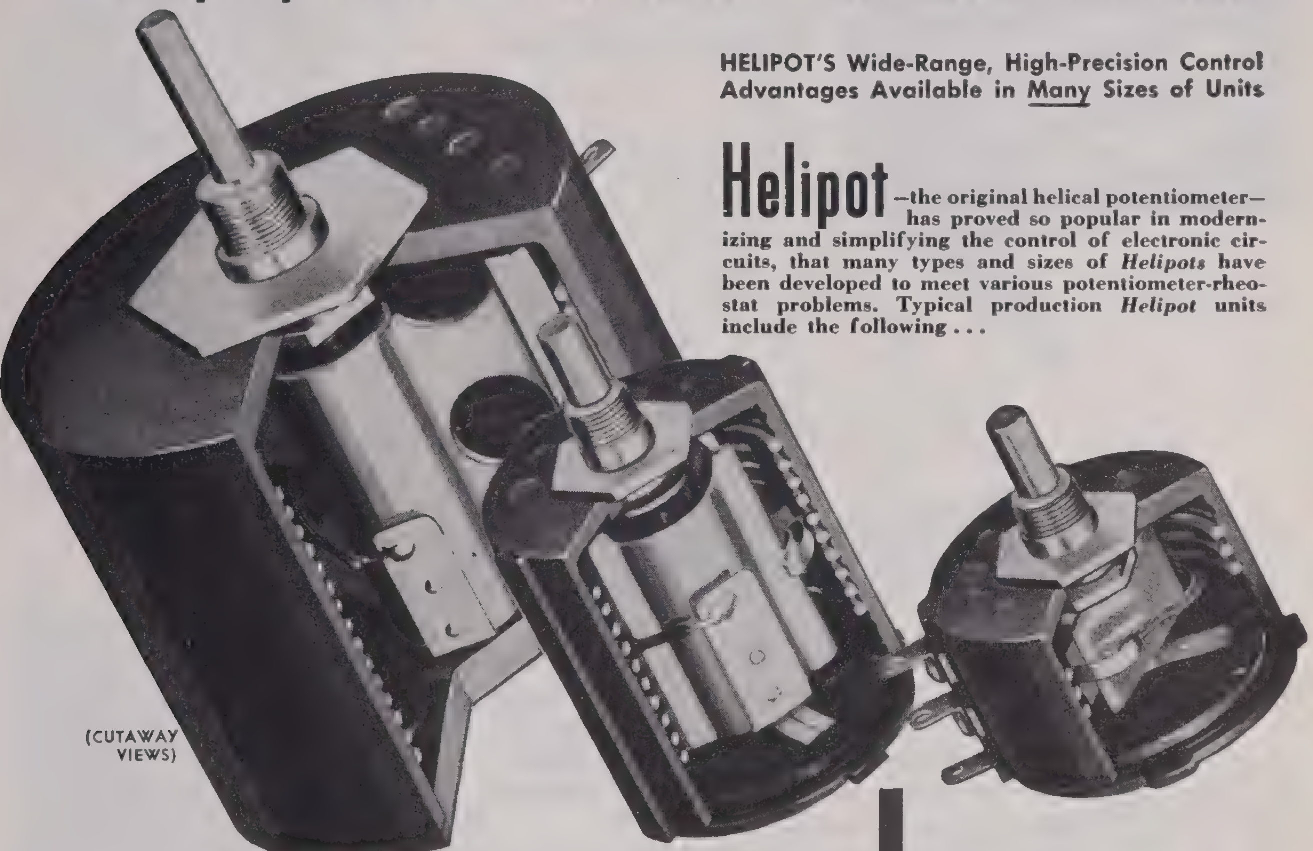
There's a Beckman Helipot

(Trade Mark of the **HELI**cal **POT**entiometer)

to simplify YOUR Potentiometer—Rheostat Problems!

HELIPOT'S Wide-Range, High-Precision Control Advantages Available in Many Sizes of Units

Helipot—the original helical potentiometer—has proved so popular in modernizing and simplifying the control of electronic circuits, that many types and sizes of *Helipots* have been developed to meet various potentiometer-rheostat problems. Typical production *Helipot* units include the following . . .



(CUTAWAY VIEWS)

MODEL B—Case diameter—3.3″; Number of turns—15; Slide wire length—140½″; Rotation—5400°; Power rating—10 watts; Resistance ratings—50 to 300,000 ohms.

MODEL A—Case diameter—1.8″; Number of turns—10; Slide wire length—46½″; Rotation—3600°; Power rating—5 watts; Resistance ratings—10 to 100,000 ohms.

MODEL C—Case diameter—1.8″; Number of turns—3; Slide wire length—13.5″; Rotation—1080°; Power rating—3 watts; Resistance ratings—5 to 30,000 ohms.

WIDE CHOICE OF DESIGN FEATURES

Not only are *Helipots* available in a wide range of sizes and ratings, but also can be supplied with various design features to meet individual requirements . . .

- ▶ Available with special length shafts, flatted shafts, screw-driver slots, etc.
- ▶ Can be supplied with shaft extensions at each end to permit coupling to indicating instruments or other devices.
- ▶ May be provided in ganged assemblies of two or three units, all operating from a common shaft.
- ▶ Available with linearity tolerances of 0.1%—and even less.
- ▶ Models A & B can be modified to include additional taps at virtually any point on windings.

. . . and many other special features.

Investigate the many important advantages to be gained by using the *Helipot* in your electronic control applications. Write outlining your problem!

Have you latest data on DUODIAL—Tthe turns-indicating knob dial? If not, write!

SPECIAL MODELS

In addition to the above standard *Helipot* units, special models in production include . . .

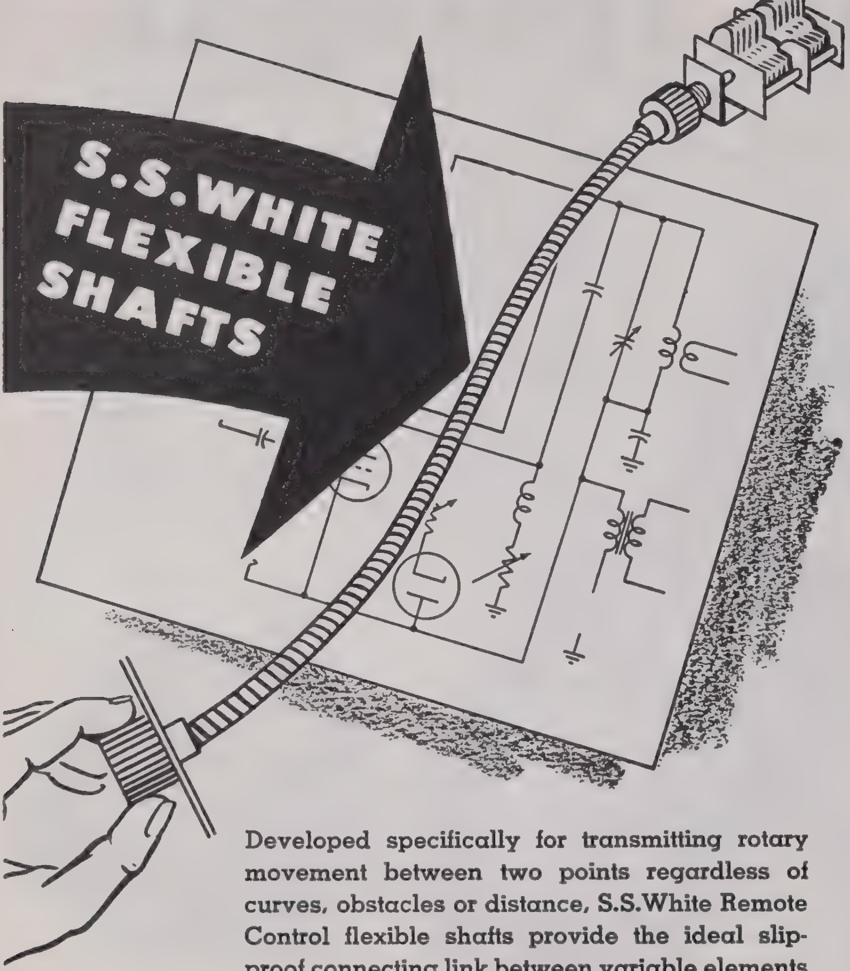
MODEL D—Similar to Model B, above, but longer and with greater length of slide wire. Case diameter—3.3″; Number of turns—25; Slide wire length—234″; Rotation—9000°; Power rating—15 watts; Resistance ratings—100 to 500,000 ohms.

MODEL E—Similar to Model B, but longer and with greater length of slide wire than Model D. Case diameter—3.3″; Number of turns—40; Slide wire length—373″; Rotation—14,400°; Power rating—20 watts Resistance ratings—150 to 800,000 ohms.

Send for HELIPOT Literature!

THE Helipot CORPORATION
SOUTH PASADENA 6, CALIFORNIA

Positive, sensitive, trouble-free CONTROL for variable elements



Developed specifically for transmitting rotary movement between two points regardless of curves, obstacles or distance, S.S.White Remote Control flexible shafts provide the ideal slip-proof connecting link between variable elements and their control knobs.

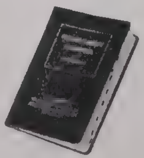
With proper selection and application of the shaft, any required degree of sensitivity can be obtained.

And, as you can appreciate from the sketch above, the arrangement facilitates equipment design, because it permits both the variable element and the control to be located wherever you want them.

Furthemore, these shafts are practically immune from trouble and require no attention.

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

It contains basic information about flexible shafts and shows how to select and apply them. Copy sent free to any engineer who writes for it on his business letterhead and mentions his position.



S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT. G 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

News—New Products

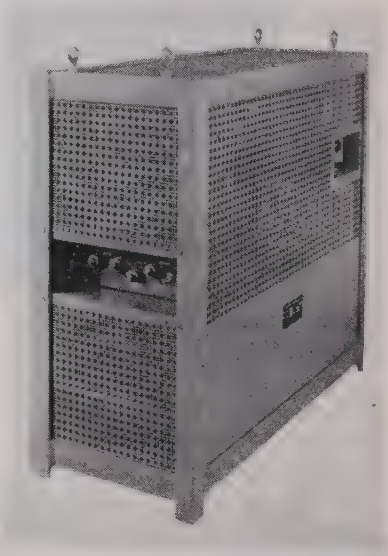
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

Voltage Regulation

Increasing development of precise electronic components will require a more widespread use of power supplies for electron tube and experimental operations possessed of good regulating qualities. Each month sees announcement of one or more of these units, for applications where the user does not care to undertake their construction. Too, fuller recognizance of this principle is finding application in the supply of primary power to complete installations of radio and electronic equipment. Broadcast transmitters located in the outlying districts or at the end of long power feeder lines are a point in demonstration of this thesis.

The Howard Co., 934 Argyle Road, Drexel Hill, Pa. comes up with a new unit of sufficiently small dimensions to find ready application on the laboratory bench, or for incorporation into completed units. It is capable of delivering 60 watts total regulated power (300 volts, 200 ma), with 1-volt regulation from zero to full load and with a line-voltage variation of ±10 volts from the design center. Ripple is so low as to serve well when operating high-gain amplifiers, and the constancy of regulation is exceptional over long periods of operation.



Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn., have announced models for primary power regulation, of 5 and 10 kva capacity. These will serve the low-power stages of a high-powered transmitter, thus affording constant voltage to the frequency regulating stages, or will provide sufficient capacity to power a whole laboratory of test equipment for precise measurement techniques. The phase distortion is low in all models, but a special design is offered where this factor may prove an important consideration. Frequency shift from 60 to 50 cycles will not affect the accuracy of these units. Full descriptive literature is available from the makers.

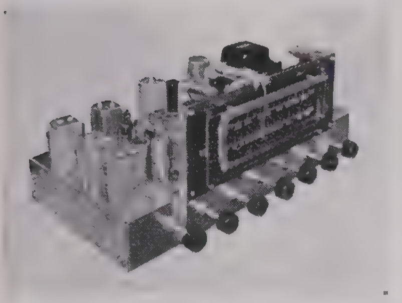
(Continued on page 59A)

News—New Products

These manufacturers have invited PROCEEDINGS information. Please mention your I.R.E. affiliation. readers to write for literature and further technical

(Continued from page 48A)

FM and AM Tuner



Browning Laboratories, Winchester, Mass., has just announced their latest model RJ-20 FM and AM tuner, with inbuilt preamplifier and tone-compensating networks.

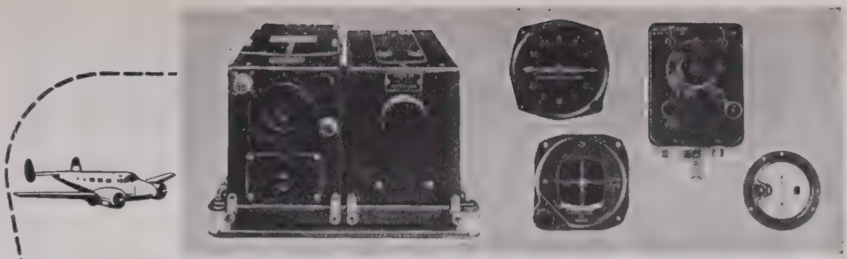
This is a precision type of instrument appealing to the laboratory type of application, the custom builder of equipment, and for broadcast monitoring of program content and station performance. Two separate tuners are mounted on one chassis, the AM section incorporating a set of band-expanding if transformers, with an 8-kc and 18-kc bandwidth position, controlled from a panel switch. The FM section employs separate oscillator and mixer triode tubes, dual limiters and discriminator in a fully licensed Armstrong circuit, for finest FM reception. Sensitivity is such that 10 microvolts input signal will produce 32 db of quieting at full audio fidelity.

The audio amplifier is a two-stage cascade unit, common to both tuning sections, and also providing a phonograph input channel. Between the two tubes are a series of $R-C$ tone compensating networks, to provide for attenuation and equalization of both ends of the audio spectrum. As the phonograph input operates through this system, it can be equalized too. A power supply for the tuner is integral with the chassis.

Plant Expansions

Tech Laboratories, Inc., has announced the purchase and occupancy of their own building at Bergen & Edsall Boulevards, Palisades Park, N. J. Long occupying rented space in Jersey City, their increased sales volume necessitated this move to more than 17,000 square feet of office and production space. The location is 1½ miles south of George Washington bridge, on route S-1. On the hilltop location, unobstructed light is afforded to all areas of the 100% air-conditioned building. These factors will contribute to the high standards of technical excellence and engineering integrity long recognized as a feature of the attenuators, resistances, and switches associated with this firm. Increased laboratory facilities for special contract work have been provided in the new quarters.

(Continued on page 61A)



The Magic of VHF

Airborne Equipment for;
OMNI-DIRECTIONAL RANGES
RUNWAY LOCALIZERS
VISUAL-AURAL RANGES
SIMULTANEOUS VOICE
GCA VOICE RECEPTION

The Type 15A VHF Navigational Receiving Equipment (illustrated) provides for reception on the new Omni-Directional Ranges as well as operation on both types of VHF Runway Localizers, and the VHF Visual-Aural Airways Ranges. Simultaneous voice feature is included on these ranges. The *tunable* A.R.C. Receiver permits selection of any VHF aircraft frequency.

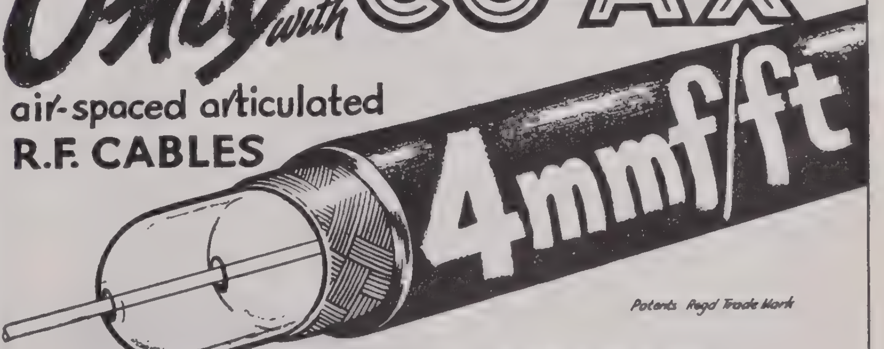
The A.R.C. Type 17 or A.R.C. Type 18 is the companion communication equipment normally associated with the Type 15A. The Type 17 VHF Communication Equipment adds independent two-way VHF communication facilities. The Type 18 adds VHF Transmitting Equipment only. All Type 17 and 18 units are type-certificated by the CAA.

The dependability and performance of these VHF Communication and Navigation Systems spells increased safety in flight. Specify A.R.C. for your next installation.

ARC
Aircraft Radio Corporation
BOONTON, NEW JERSEY
DEPENDABLE ELECTRONIC EQUIPMENT SINCE 1928

Only with CO-AX

air-spaced articulated
R.F. CABLES



Patents Regd Trade Mark

THE LOWEST EVER
CAPACITANCE OR
ATTENUATION
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We are specially organised to handle direct enquiries from overseas and can give

IMMEDIATE DELIVERIES FOR EXPORT

Write or cable for data sheets or deliveries to the Originators of flexible air-spaced R.F. Cables

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD·LONDON SW7 ENGLAND
CABLES: TRANSRAD. LONDON.

LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft at 100 Mc/s	LOADING Kw	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	HIGH POWER FLEXIBLE
A 34	73	0.6	1.5	0.88	
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C 33	4.8	220	2.4	0.64	V.L.C. ★
C 44	4.1	252	2.1	1.03	

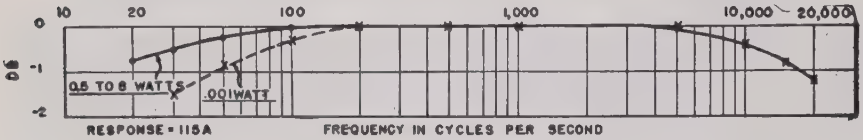
★ *Very Low Capacitance cable*

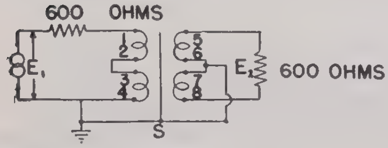
1st LINE PERFORMANCE *Proved in* ADC 2nd Line Transformer

AUDIO
DEVELOPMENT
COMPANY

An **ADC** 115A (Industrial Series) impedance matching transformer, picked at random from stock, was submitted to tests to compare its performance with that of other makes of *1st line* transformers. Here are the results. Compare performance of the **ADC** transformer with that of other makes.

FREQUENCY RESPONSE

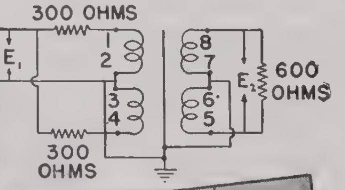




It may be noted that altho the permeability of magnetic materials drops at low flux densities, the **ADC** transformer has sufficient reserve inductance to allow for this even at low power levels. At 40 db below maximum power level it exceeds the response guarantee. Insertion loss at 1,000 cps was 0.75 db.

LONGITUDINAL BALANCE

The most common interference voltages encountered in telephone line transmission are longitudinal; that is, the induced voltages in both wires are in phase with respect to ground. These can be removed from the signal voltage only by means of a well balanced line transformer. Illustration "A" shows the test circuit used to measure the degree of removal of these interference voltages. Level reduction on the **ADC** 115A transformer was 67 db at 100 cps and 56 db at 10,000 cps.



A

CONSULT ADC for your engineered transformer where exacting specifications require positive results. **ADC's** policy assures you the finest available materials and workmanship to give you the very best electronic components.

ADC QUALITY PLUS TRANSFORMERS

Finest transformer made. For AM and FM broadcast stations and recording studios. ± ½ db 30-15,000 cps.

MANUFACTURERS, JOBBERS:
Write today for catalog of ADC electronic components or for information on units engineered to your requirements.

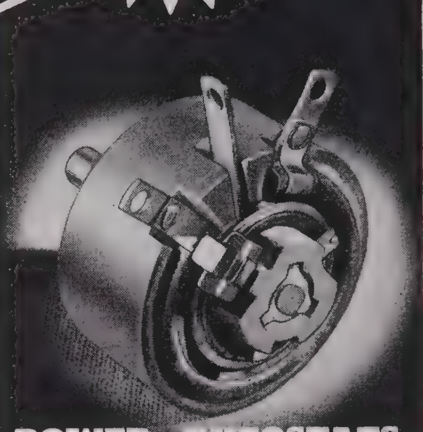
AUDIO DEVELOPMENT

Audio Development Co.

2835 13th AVE. S., MINNEAPOLIS 7, MINN.

"Audio Develops the Finest"

RUGGED!



POWER RHEOSTATS

★ Yes, RUGGED — mechanically and electrically. That's why Clarostat Power Rheostats are found in so many radio-electronic and electrical assemblies that must stand up.

Insulated metal core for winding. Element imbedded in exclusive cold-setting cement. Maximum heat dissipation for cooler, longer-lasting operation. Smoothest rotation. Positive conduction, always.

25- and 50-watt ratings. 1-5000 and 0.5-10,000 ohms, respectively.

Write for Bulletin 115. Let us quote on your control and resistor needs.

CLAROSTAT

Controls and Resistors

CLAROSTAT MFG. CO., Inc., Dover, N. H.

In Canada: CANADIAN MARCONI CO., Ltd.
Montreal, P.Q., and branches

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

Plant Expansions

Sylvania Electric Products Inc., commenced production about October 1 in their new television tube manufacturing plant located at Ottawa, Ohio. Increased interest over the nation in television, translated into increased receiver production and sales, has called for the construction of increased capacity for making of cathode-ray tubes used in direct viewing receiving sets. Opening of this new plant will supplement the output of the two factories currently in production at Emporium, Pa., and afford facile distribution of the finished product to the makers in the Chicago area, largest center of video receiver production, in this country.

At Waterford, N. Y., the **General Electric Co.** has opened a new plant for the production of its many silicone products to commence production at full capacity, this fall. Partial operation has been going on for about a year. Many forms of this new series of chemical products will be formulated at this new manufacturing facility, including the famous "bounding putty" used as a center material for golf balls, with signal success.

(Continued on page 64A)

DIALCO

PILOT LIGHT ASSEMBLIES

PLN SERIES—Designed for NE-51 Neon Lamp

Features

- THE MULTI-VUE CAP
- BUILT-IN RESISTOR
- 110 or 220 VOLTS
- EXTREME RUGGEDNESS
- VERY LOW CURRENT

Write for descriptive booklet

The DIAL LIGHT CO. of AMERICA
FOREMOST MANUFACTURER OF PILOT LIGHTS
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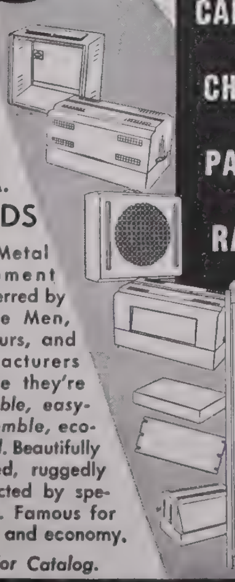

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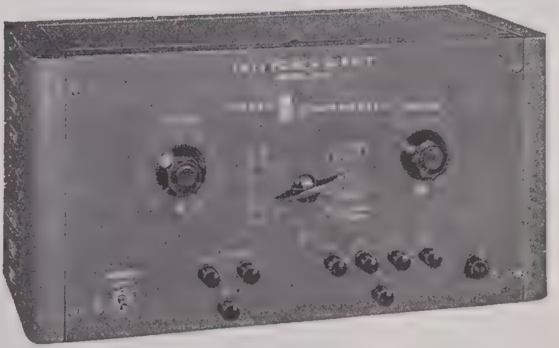

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Technology Instrument Corporation's newly developed Type 110 Slide Wire Resistance Boxes represent a big step forward in the design of specialized instruments for student and general laboratory lse. A combination of high accuracy, wide resistance range and convenient size, the Type 110 is suitable for use at audio and super-sonic frequencies.

Its compactness combined with its low cost make it possible to provide more of these important instruments for college and industrial laboratories. Yet it is suitable for use in most cases where a more elaborate decade box is used.

The Type 110 Slide Wire Resistance Boxes consist of a precision non-inductive decade resistor and a continuously adjustable slide wire resistor which provide a useful, direct-reading resistance range ratio of 1000 to 1. Two models are now available: Type 110-A, with a range of 0-11,000 ohms; and Type 110-B, with a range of 0-110,000 ohms. Send a trial order today—or if you prefer, ask for detailed information.

SPECIFICATIONS

Accuracy—Decade resistance cards adjusted to within 1% of nominal values. Slide wire resistors direct-reading to within 1% of maximum resistance.

Temperature Co-efficient—Slide wire and decade resistors have temperature co-efficient of less than 0.00002 parts per degree C. at room temperature.

Mounting—Cast aluminum cabinet, aluminum panel. All resistance elements and switches completely enclosed. Dimensions: 4" wide 8⅝" long, 5⅜" high. Net weight, 4 lbs.

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Type 110-A: 0-11,000 ohms, 2 dials	$42.50
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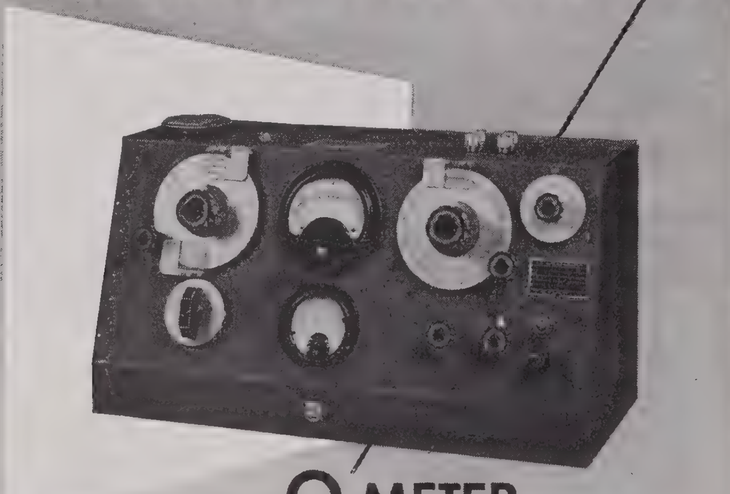

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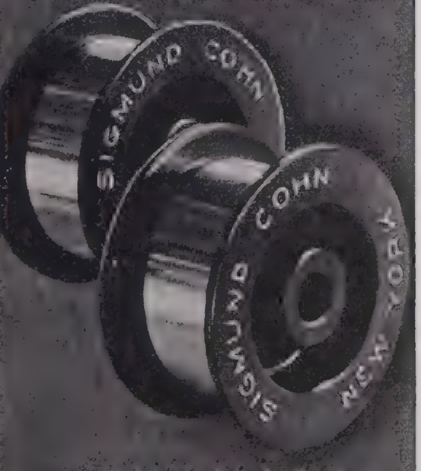

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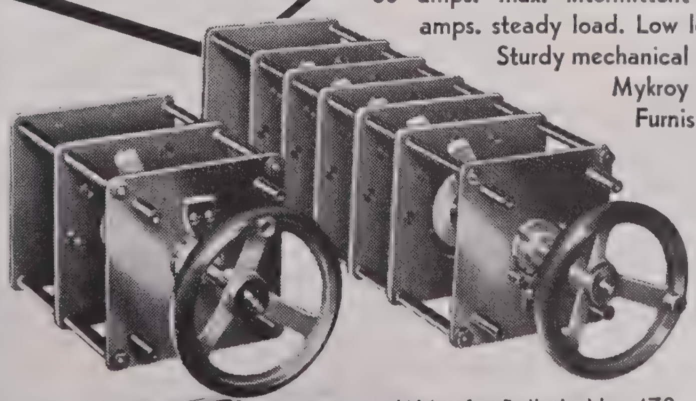

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Further details in Bulletin RE-812.

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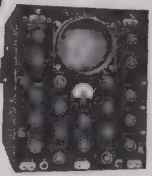

Provides a variety of time bases, triggers, phasing and delay circuits, and extended-range amplifiers in combination with all standard oscilloscope functions.

Extended-range amplifiers: vertical, flat within 3 db 5 cycles to 6 megacycles; horizontal, flat within 1 db 5 cycles to 1 megacycle ● High sensitivity: vertical, 0.05 RMS volts per inch; horizontal 0.1 RMS volts per inch ● Single-sweep-triggered time base permits observation of transients or irregularly recurring phenomena ● Variable delay circuit usable with external or internal trigger or separate from 'scope ● Sawtooth sweep range covers 5 cycles to 500 kilocycles per second ● 4,000-volt acceleration gives superior intensity and definition. Request Bulletin RO-812.

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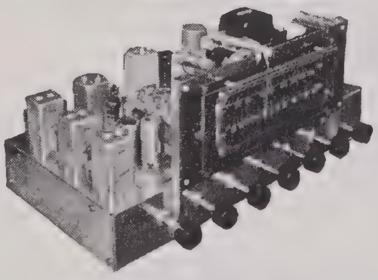

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- New 6AL7 tuning eye for precise tuning on strong or weak FM stations.
- Self-contained power supply.

See, hear, and handle this new Browning Tuner . . . and enjoy new satisfaction in your radio and music reproduction.

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Data Sheet RT-812

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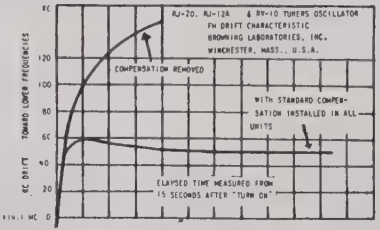
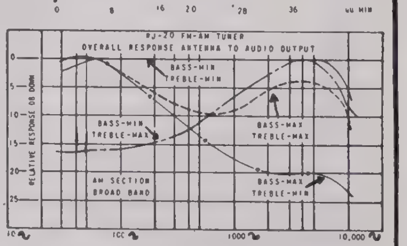
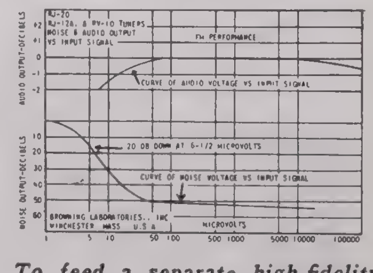
to satisfy the man who knows radio . . . provable by both instrument and listening tests.

CHECK THESE CURVES
and you'll see why Browning Tuners are chosen by those who insist upon the best.







To feed a separate high-fidelity audio system, use the Browning RJ-12A for FM/AM or the Browning RV-10 for straight FM. They're all "tops" in the high-fidelity field.

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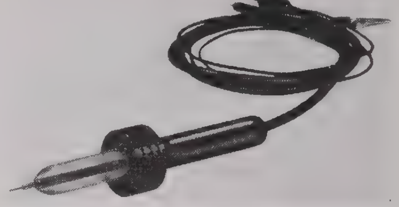
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 61A)

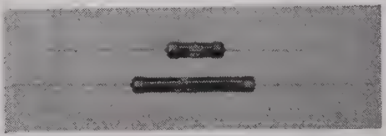
Safety Test Probes

Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y., has announced high-voltage testing probes, constructed with internal shielding and flashover protection to safeguard the life of the user.



When the proper interchangeable resistor is installed, they will extend the range of many makes of test apparatus to 30 kilovolts, and beyond, still affording complete safety in the hands of the operating personnel. Sensitive test instruments and vacuum-tube voltmeters can be extended in the range over which they will perform through incorporation of these new accessories.

Recent Catalogs



International Resistance Co., 401 N. Broad St., Philadelphia Pa., announce in their bulletin B-4 a new series of deposited carbon resistors, in ranges of 200 ohms to 20 megohms. Multiple layers of lacquer protect the units from mechanical damage, high stability of resistance, and low voltage co-efficient, are advantages claimed for these 1- and 2-watt units. They are supplied with soft copper leads, securely anchored to the silvered end caps.

Ebert Engineering & Manufacturing Co., 185-09 Jamaica Ave., Hollis, L. I., N. Y., announce data on their line of high current-carrying-capacity mercury relays, approved by the Underwriters Laboratories. These are available in 2- and 3-pole units, the current-carrying parts being totaly glass-enclosed, and capable of handling up to 35 amperes. Coil operation is designed for d.c. or half-wave rectified, unfiltered a.c. Small physical size increases designer interest in this new line, where space requirements impose rigid limitations.

(Continued on page 65A)

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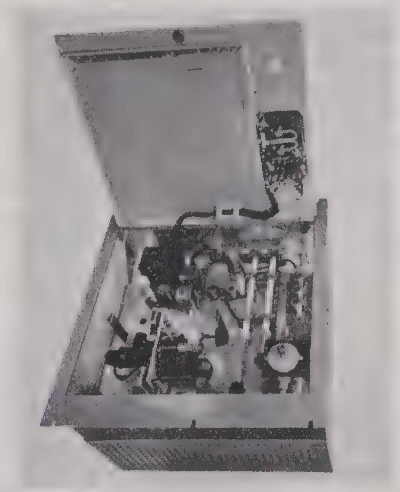
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 64A)

STL FM Broadcast Transmitter

Federal Telephone & Radio Corp., 100 Kingsland Road, Clifton, N. J., has entered the studio-to-transmitter radio link market with the announcement of their 3-watt direct-frequency-modulated klystron-oscillator transmitter cut shown, and receiver units, incorporating parabolic antenna units. Because of this feature, low power will afford reliable line-of-sight transmission over approximately 30 miles. The single-superheterodyne receiver, employing a similar klystron as a local oscillator, and with automatic-frequency-control circuits, affords a stability of 0.01%.



Provision on both units, which are relay rack mounted, is made for full metering of tube circuits and aural monitoring. Characteristics meet the RMA and FCC requirements for this service, when used as a broadcasting station studio-to-transmitter location link. Small physical size and accessibility of all components are features that will appeal to the operating and servicing personnel of the station using this equipment.

Recent Catalogs

American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill., have issued Bulletin A-1, a complete listing of their line of AN connectors for power, signal and control circuits in aircraft and electronic applications. Thousands of types are listed in detail, under group headings, together with an index to locate specific fittings by their designation numbers. Assembly data on many types are included, as well as a listing showing some typical cable-harness arrangements which have been built at this firm's factory to specific order, using many of the connectors listed in the catalogue. Design engineers will appreciate the engineering factors shown as advantages of the Amphenol line.

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MICROWAVES and
RADAR
ELECTRONICS

By ERNEST C. POLLARD and
JULIAN M. STURTEVANT,
both of the Yale University faculty

•

This book by two experts in the field is the most up-to-date treatment of the subject of microwave electronics. It not only covers wartime work in radar, but also includes developments that have taken place as recently as the last few months. In this volume, the authors treat pulse circuits as a unified field, and discuss radar as only one of many possible applications of microwave electronics. The clear, concise language of the book makes it understandable to those with only a basic physical background. The rapid progress in the field of microwave electronics, during and since the war, makes this book essential reading for the communication engineer.

Contents

Electromagnetic Fields and Microwaves; Coaxial Lines, Wave Guides, and Cavities; The Production of Microwaves; Microwave Technique; Pulse Circuits; Cathode Ray Tube Indicators; Tubed Amplifiers; Amplification of Very Weak Signals; Servomechanisms and Computers; Miscellaneous Circuits; Radar and Its Accessories; Microwave Communications; Microwaves and Physical Research; Appendix 1—The Fourier Integral. Appendix 2—Curl and Stokes Theorem. Appendix 3—Units.

1948
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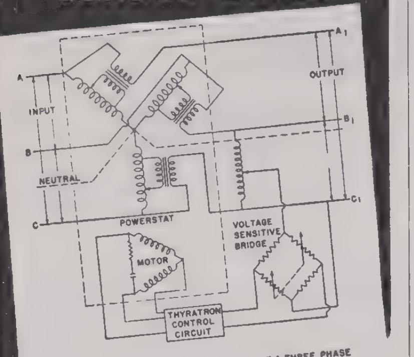

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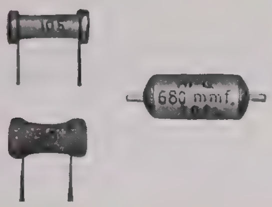

HI-Q TEMPERATURE COMPENSATING CAPACITORS

HI-Q temperature compensating capacitors are available in three types. CN & SI types with capacities from .25 mmf to 1830 mmf and CI types from .25 mmf to 595 mmf with a temperature coefficient range from P 100 to N 1400. All of these **HI-Q** styles are of tubular ceramic construction with pure silver electrodes precision coated. Style SI is insulated with a synthetic coating of Durez, style CN is of Styrene and CI is Steatite covered.

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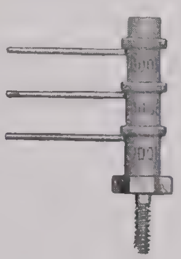
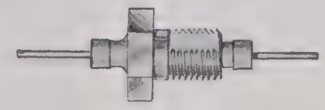
HI-Q General Purpose Ceramic Capacitors readily replace mica and paper condensers of corresponding values. **HI-Q** General Purpose Ceramic Capacitors should not be confused with the **HI-Q** line of close tolerance temperature compensating units. **HI-Q** General Purpose Ceramic Capacitors are available in capacity ratings from 5 mmf to 33,000 mmf.

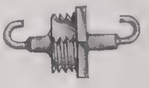


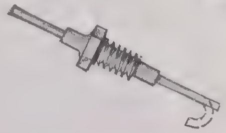
HI-Q STAND-OFF CAPACITORS

HI-Q "stand-off" capacitors are basically tubular with a screw fixture for mounting to the chassis or common ground. Close coupling and their unique construction make them an excellent choice for by-passing RF in the high frequencies. Standard capacity tolerances are ±10% and ±20% for "stand-off" capacitors and −20% and +30% for multiple tap units. Closer tolerances available wherever economical manufacturing permits. All units flash tested for 1000 volts DC with power factor under 3% maximum and insulation resistance is above 10,000 megohms. All units stamped for capacity.

HI-Q FEED-THRU CAPACITORS



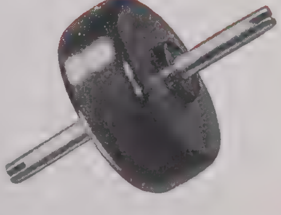




HI-Q "feed-thru" capacitors provide perfect transmission through the chassis or ground, as well as by-passing to ground. The high quality construction of **HI-Q** "feed-thru" capacitors, is extremely rugged and will withstand severe vibration, making them ideal for use in mobile and aircraft applications.

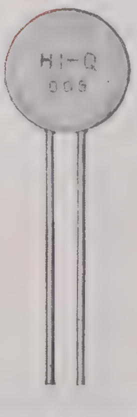
HI-Q HIGH VOLTAGE CAPACITORS

HI-Q HV Capacitors are a sturdy unit, capable of withstanding high voltages, operating at extreme humidity and raised temperatures. They are a natural television component. The basic dielectric is body 20, encased in a low loss, mineral filled bakelite. Available in capacities 50 mmf to 1,000 mmf. Specify desired capacity after type HV when ordering.



HI-Q DISC CAPACITORS

HI-Q Disc Capacitors are high dielectric by-pass, blocking or coupling capacitors. Designed for application where its physical shape is more adaptable than tubular units. The placement of leads is such that close connections are easily made, thus reducing inductance to a minimum, a much desired feature in high frequency designs, such as television and FM. Available in three types: BPD-5: .005 MFD guar. min., BPD-10: .01 MFD guar. min. and BPD-1.5: .0015 MFD guar. min.



WRITE FOR FREE CATALOG

HI-Q *Electrical Reactance Corp.*

FRANKLINVILLE, N. Y.

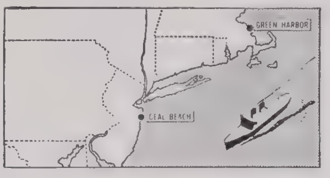
Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

PROCEEDINGS OF THE I.R.E., December, 1948, Vol. 36, No. 12. Published monthly in two sections by The Institute of Radio Engineers, Inc., at 1 East 79 Street, New York 21, N.Y. Price $2.25 per copy. Subscriptions: United States and Canada, $18.00 a year; foreign countries $19.00 a year. Entered as second class matter, October 26, 1927, at the post office at Menasha, Wisconsin, under the act of March 3, 1879. Acceptance for mailing at a special rate of postage is provided for in the act of February 28, 1925, embodied in Paragraph 4, Section 412, P. L. and R., authorized October 26, 1927.

Table of contents will be found following page 32A

the voice that

STEPPING-STONES TO PROGRESS IN MARINE RADIOTELEPHONY



The first ship-to-shore radiotelephone communications were established almost 30 years ago between land stations at Green Harbor, Mass., and Deal Beach, N. J., and the steamers "Ontario" and "Gloucester," operating between Boston and Baltimore.

The "Leviathan" was the first ship to handle radiotelephone messages as a public service to and from land telephones.

This selector set made it possible to dial ships at sea, and eliminated the need for constant monitoring by loudspeaker or headphones.

IT'S COMMONPLACE TODAY to pick up a telephone on shipboard and talk to a business associate on land. But little more than 30 years ago, this was just a dream.

Back in 1915, the spoken voice could travel to far places only by wire. Then telephone scientists developed the radiotelephone, and soon the spoken word was winging its way across the ocean. A further use of this new magic was soon proposed: could not the human voice be sent from shore to ships at sea?

Soon sub-chasers and other small Navy craft were talking to each other over equipment designed by Bell engineers. And in experiments starting in 1919, the men on two coastwise steamers talked through land stations to land telephones of the Bell System.

These early experiments covered fairly short distances. But in the meantime, telephone calls across the Atlantic by radio had become an ordinary occurence. So . . . why not 'phone calls to ships way out in *mid*-Atlantic?

Of course, long-distance ship-to-shore radiotelephony brought up problems of varying distances and directions—problems not encountered in point-to-point transmission. Bell Telephone Laboratories solved these problems with the design of the "Leviathan's" equipment. For the first time, long-range marine radiotelephony became a reality.

Later, Bell Laboratories scientists developed selective ringing, which made it possible to *dial* particular ships at sea. The basic elements of practical marine radiotelephony had now been developed.

BELL SYSTEM
AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.

links the ship and the shore

In addition to producing radiotelephone equipment for the largest ocean liners, Western Electric for many years manufactured the 224, 226 and 227 type sets, which brought the benefits of radiotelephone facilities to coastwise vessels and small craft.

These sets provided power capacities ranging up to 100 watts. As the Bell System had tremendously expanded its chain of harbor stations, coastal craft were normally near a shore station. Hence these capacities were ample to maintain contact with land.

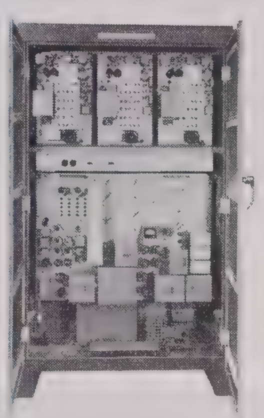
There still existed, however, no equipment specifically designed for tankers, freighters and smaller passenger ships plying the *ocean* lanes. This need has been filled by the introduction of the Western Electric 248A.

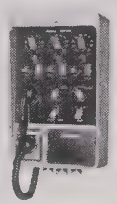
This new equipment provides 250 watts of transmitted radio frequency carrier power, resulting in greatly increased range. Provision is made for transmission and reception on the frequencies of the high-seas shore stations (as well as on the coastal harbor and ship-to-ship channels). Because of these two features, a ship equipped with the 248A, at practically any point on world trade routes, can establish contact with a land station.

The 248A combines this advantage with the compactness and simplicity of operation essential on smaller ships.

—QUALITY COUNTS—

THE NEWEST IN MARINE RADIOTELEPHONE EQUIPMENT





Left: Main cabinet of 248A mounting transmitter and three receivers.
Above: Remote control unit.

The long experience of Bell Laboratories and Western Electric in design and manufacture of marine radiotelephone equipment has culminated in the 248A—compact, powerful, simple to operate.

A single cabinet houses the transmitter and three receivers. Each of the three receivers can be tuned to any one of 10 pre-set frequencies; the transmitter to any one of 30. Transfer from one frequency to another is accomplished simply by turning knobs on the remote control panel.

Because three receivers are used, it is possible for the ship to monitor simultaneously on three different channels. The set is designed to permit easy installation of selective equipment to allow dialing the ship from shore stations.

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

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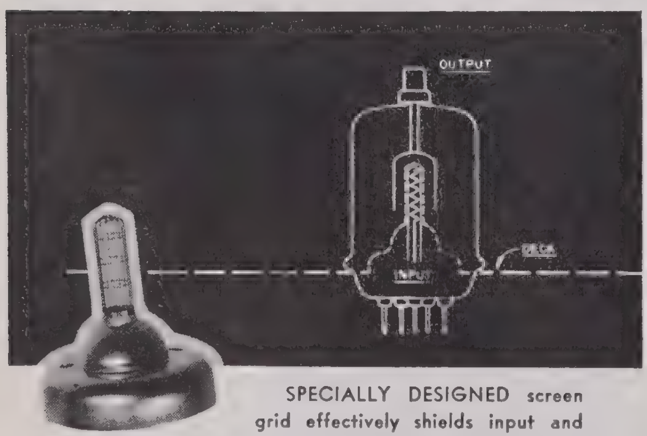
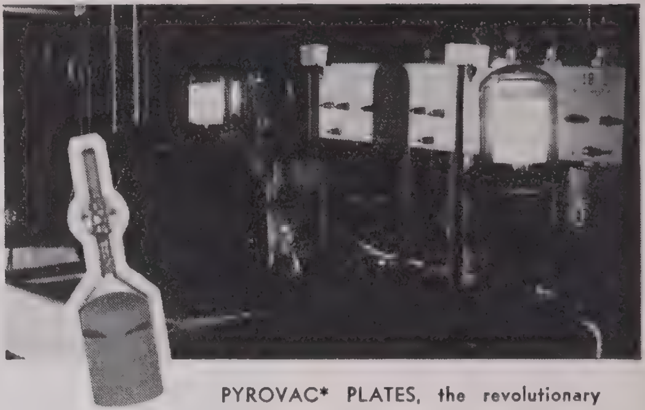
THEY'RE BETTER BECAUSE...

the EIMAC 4-65A

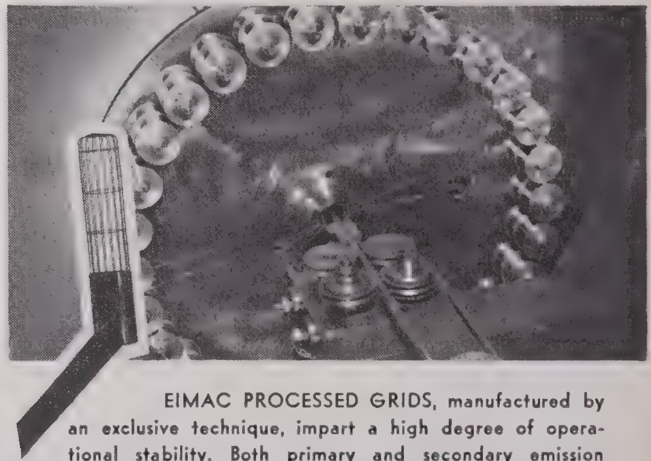
APPLIED RESEARCH by Eimac engineers has produced a thoriated tungsten filament with ample reserve emission. Its instant heating characteristics make the 4-65A well adapted to mobile application.



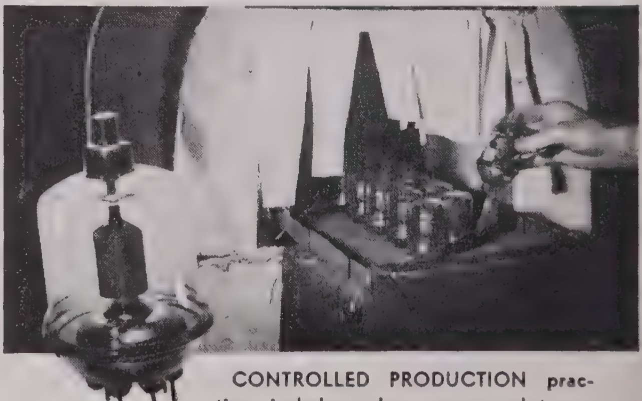
SPECIALLY DESIGNED screen grid effectively shields input and output circuits, within the tube, without excessive screen power. All internal structures are self supporting without the aid of insulating hardware.



PYROVAC* PLATES, the revolutionary Eimac development, withstand excessive abuse. Manufactured by an advanced technique, these plates can handle momentary overloads in excess of 1000%, consequently they contribute appreciably to the tube's life.



EIMAC PROCESSED GRIDS, manufactured by an exclusive technique, impart a high degree of operational stability. Both primary and secondary emission are controlled.



CONTROLLED PRODUCTION practices include a slow oven-anneal to remove the last vestige of residual strains, and four to eight hours of testing under severe VHF conditions.

These are but some of the features that combine to make the Eimac 4-65A a better tetrode. It is unexcelled in its category as a power amplifier, oscillator or modulator. For example, in typical operation as a power amplifier or oscillator (class-C telegraphy or FM telephony) one tube with 1500 plate volts will supply 170 watts of output power with less than 3 watts of driving power. A complete comprehensive data sheet on the 4-65A has just been released. Write for your copy today.

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SERVO-MECHANISMS: Control to any desired accuracy. Power as desired. Linear control, logarithmic control.

AMPLIFIERS: R.F., Video, A.F., D.C. to fit any application. Particular emphasis on high gain, high stability characteristics.

OSCILLATORS: All frequencies.

POWER SUPPLIES: Electronic — Regulation ½% and less.

REGULATORS: Electronic — direct or through servo control. Regulation, drift, etc. to specification.

MEASUREMENT—CONTROL: Devices for measuring and control of all parameters capable of being controlled and producing proportional electrical, optical or measuring displacement. Electronic microammeters, radiation counters.

CONTROL OF ACCELERATOR ACCESSORIES: Grouping of controls, supplementary apparatus, and experimental system into a compact versatile unit.

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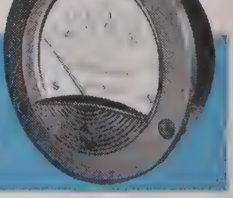
ELECTRONICS
Designers

NOW AVAILABLE FOR YOUR COMMERCIAL APPLICATIONS

CAPACITOR PULSE-FORMING NETWORKS

Developed by General Electric and proven by the thousands in the war, these compact units are now available for any commercial use. They find application in radar and industrial equipment where the normal capacitor discharge shape is not suitable and where an impulse having a definite energy content and duration is required. The network consists of one or more equal capacitor sections and the same number of inductance coil sections. Both capacitors and coils are hermetically sealed in the same metal container. Networks are treated with top quality mineral oil to provide stability of capacitance characteristics over a wide range of ambient temperatures. Sizes from which you can make your selection range from a 0.5-kw output rating to 4500-kw. Write for bulletin GEA-4996.

DESIGNED FOR BETTER READABILITY

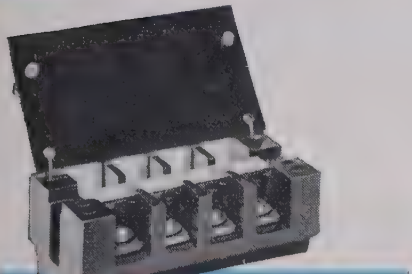


General Electric's new line of 3½-inch thin panel instruments will save space and add to the appearance of your panels. They're dust-proof, moisture resistant, and vibrations normally encountered in aircraft and moving vehicles have no adverse effects. Especially designed for better readability, the scale divisions stand out by themselves. Lance-type pointers and new-style numbers mean faster reading. Available in square and round shapes, depth behind the panel is only 0.99 inches. Construction is of the internal-pivot type, with alnico magnets for high torque, good damping, and quick response. Check bulletin GEA-5102.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

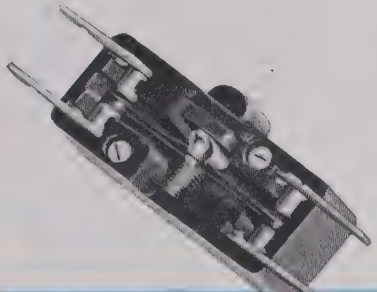


SIMPLIFY CONTROL WIRING WITH THESE TERMINAL BOARDS

Easy-action hinged covers protect control wiring, help give your product a neat appearance. Hook-ups are easy with the hard-gripping connectors. Simply strip the wire end, screw down the connector on the bare wire. Blocks are durable, too, constructed of strong Textolite with reinforced barriers between poles to insure against breakage. Marking strips are reversible—white on one side, black on the other. These terminal boards are available with 4 to 12 poles, 2 inches wide, 1¼ inches high. Send for bulletin GEA-1497C.

HOLDS OUTPUT VOLTAGE CONSTANT

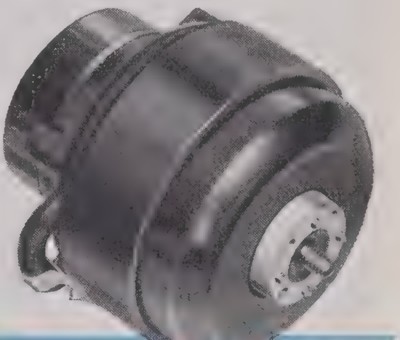
This latest addition to G.E.'s line of automatic voltage stabilizers comes in 15-, 25-, and 50-va ratings. Output is 115 volts, 60 cycles. The small size of the unit makes it particularly applicable to shallow-depth installations in many types of equipment. You may have a job for this unit which will give you automatically stabilized output voltage at a low cost. There are no moving parts, no adjustments to make; long service is assured. Check bulletin GEA-3634B for more information about this and other G-E voltage stabilizers.



LOOKING FOR LIGHTWEIGHT SWITCHES?

Switchettes* are designed for applications which require a manually operated electric switch in a limited space. Though small, these switchettes are lightning fast in action and are built to withstand severe service. A wide variety of forms and terminal arrangements makes them particularly useful where special circuit arrangements are necessary. Switchette shown above has one normally open and one normally closed circuit, transferable when button is depressed. Check bulletin GEA-4888.

*Switchette is General Electric's trade name for these small snap switches.



FOR YOUR COOLING FANS

Here's a fractional-horsepower fan motor suitable for many uses because of its compact design, low servicing requirements, and extreme quietness. Long, dependable operation is assured by sturdy, totally enclosed construction. These Type KSP unit-bearing motors are of shaded pole type design with low starting torque characteristics especially applicable to fans. A continuous oil circulation system furnishes good lubrication. You can use simple, hubless, low-cost blades with the special mounting arrangement. Write for bulletin GEC-219.

General Electric Company, Section C642-19
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

☐ **GEA-4996 Capacitor Pulse-forming Networks**
☐ **GEA-5102 Panel Instruments**
☐ **GEA-1497C Terminal Boards**
☐ **GEA-3634B Automatic Voltage Stabilizers**
☐ **GEA-4888 Switchettes**
☐ **GEC-219 Unit-bearing Fan Motor**

NAME..

COMPANY..

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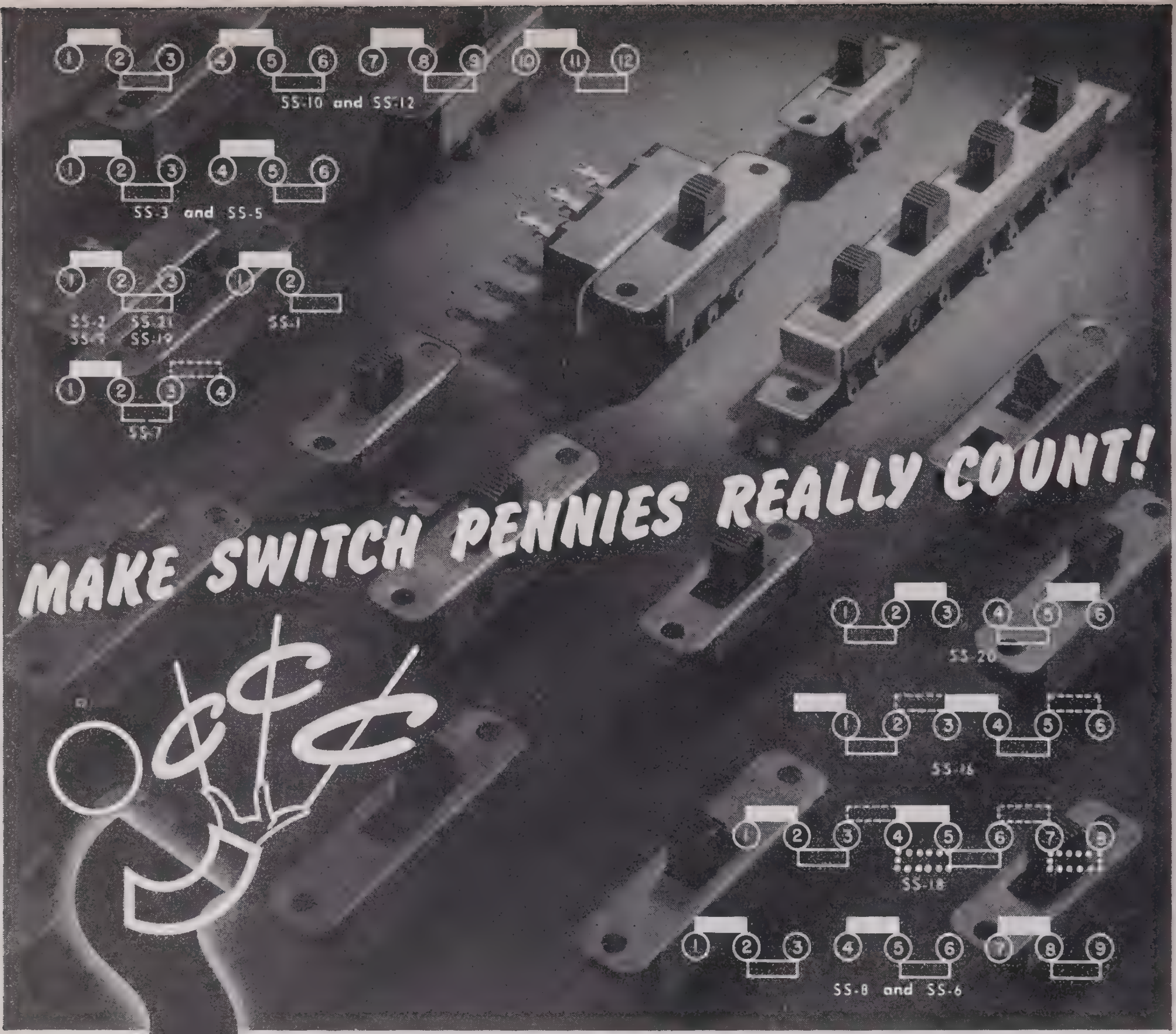
CITY...STATE.........................



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SLIDE SWITCHES

OTHER STACKPOLE PRODUCTS

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ELECTRICAL CONTACTS
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PERMANENT MAGNETS
. . . and dozens more

CONTACT CODE

POSITION 1 ▬
POSITION 2 ▭
POSITION 3 ┅
POSITION 4 ⁞⁞⁞

Name the switch contact arrangement you need! From 1 to 6 poles, up to 4 positions, with or without detent, spring return, covers, or other optional features.

Chances are Stackpole can supply exactly the right switch—promptly and inexpensively. 16 standard slide types, each designed for good appearance and real dependability, provide a low cost way of modernizing almost any electrical equipment and adding greatly to its sales appeal. Many economical adaptations can be supplied on special order to large quantity users.

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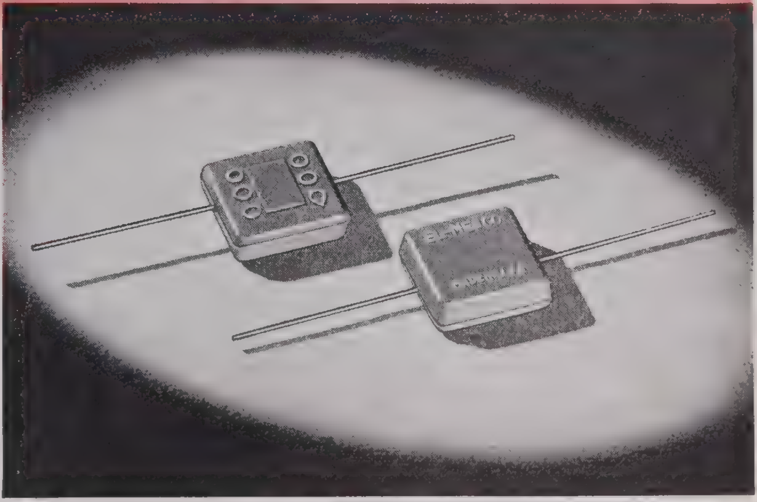
ELECTRONIC COMPONENTS DIVISION

"Because of a Nail... a Nation was lost..."*

* B ecause of a nail
a shoe was lost
B ecause of a shoe
a horse was lost
B ecause of a horse
a battle was lost
B ecause of a
battle a nation
was lost.

El-Menco

CAPACITORS, like the nail that lost a nation, are small . . . but their importance cannot be overemphasized. For *dependable* components that never "let a product down" — specify El-Menco.



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CAPACITORS

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COMPLETE FM TEST EQUIPMENT

For Broadcast Stations

Here is a complete transmitter maintenance group — providing every measurement necessary for top-flight operation from microphone to antenna! Three fast, accurate precision instruments in one compact whole — specifically designed for years of trouble-free performance — proven in service in radio stations throughout America.

These are the *-hp-* instruments that comprise this group.

1. ***-hp-* 335B Frequency and Modulation Meter.** Continuous measurement of carrier frequency and modulation swing. Low distortion audio output for measuring and monitoring.
2. ***-hp-* 206A Audio Signal Generator.** Provides continuously variable audio frequency voltage having a total wave form distortion of less than 0.1% from 50 cps to 20 kc.
3. ***-hp-* 330C Noise and Distortion Analyzer.** Measures harmonic distortion and noise level from demodulated carrier or audio channels. Built-in-vacuum-tube-voltmeter measures audio level, frequency response and gain.

All instruments have identical panel sizes for convenient mounting in relay racks. Can be delivered in colors and finishes to match your equipment.

GET FULL INFORMATION...WRITE TODAY

HEWLETT-PACKARD COMPANY
1481D PAGE MILL ROAD • PALO ALTO, CALIFORNIA

This *-hp-* Maintenance Group Makes These Essential FM BROADCAST MEASUREMENTS

Carrier Frequency: Continuously monitored with accuracy well within F.C.C. limits.

Modulation Swing: Continuously measured at instrument installation and at control console.

Modulation Limit: Alarm lamp flashes on instrument and console when pre-set level is exceeded.

Aural Monitor: Demodulated signal provides listening check for operator.

Harmonic Distortion: Measured from r-f carrier or audio channel.

Noise: Measured accurately from FM carrier or audio channel.

Frequency Response: Overall response, microphone to antenna, of individual units in transmitter set-up.

Audio Transmission: Accurately measures gain of audio channels.

Audio Level: Measured over range from +50 db to −60 db at 600 ohm level.

Equalizer Circuits: Characteristics of circuits and lines can be checked accurately, swiftly.

Oscilloscope Connections: Facilitates visual study of noise and distortion.

-hp- 335B

FM Monitor

Accurate, Stable, Easy to Operate

BRIEF SPECIFICATIONS

Frequency Range: Any single frequency, 88 to 108 mc.

Deviation Range: +3 kc to —3 kc.

Accuracy: Better than ±1000 cps.

Modulation Range: Modulation swing 100 kc. Scale calibrated 100% at 75 kc.

Audio Output: Supplied with 75 microsecond de-emphasis circuit, flat within ½ db of standard curve, 20 cps to 20 kc.

Monitoring Output: 1 milliwatt into 600 ohms, balanced, at 100% modulation.

Size: Panel 10½"x 19". Depth 13".

Precision accuracy, unique stability, new convenience and compact size—those are but a few of the reasons why this *-hp-* 335B is the finest instrument ever developed for FM broadcast monitoring. Here are additional advantages that help make this new *-hp-* instrument an ideal component of the *-hp-* FM group.

Simple to Operate. No adjustments required during operation.

Independent of Signal Level. Readings of frequency or modulation meter are unaffected by variations in transmitter level.

Unusual Stability. Low temperature coefficient crystal in temperature-controlled oven combined with specially developed electronic linear counter circuits provides accuracy far beyond that required. Measurements do not depend on accuracy of conventional discriminator circuits.

Remote Modulation Meter. Modulation may be monitored at control console or other remote point.

Low Distortion. Audio output for measuring purposes has less than .25% residual distortion.

Low Noise Level. Residual noise and hum in audio output are at least 75 db below 100% modulation.

Meets F.C.C. Requirements.

This instrument is small in size, easy to install, suitable for cabinet or rack panel mounting. Can be furnished to match your transmitter color scheme.

-hp- 206A

Audio Signal Generator

Distortion Less Than 0.1%

BRIEF SPECIFICATIONS

Frequency Range: 20 cps to 20 kc, 3 bands.

Output: +15 dbm to matched resistive loads. 10 volts available for open circuit.

Output Impedance: 50, 150, 600 ohms center-tapped and balanced. 600 ohms single-ended.

Frequency Response: Better than 0.2 db beyond output meter at all levels.

Distortion: Less than 0.1% above 50 cps. Less than 0.25% from 20 cps to 50 cps.

Hum Level: At least 70 db below output signal, or more than 100 db below 0 level, whichever is larger.

Size: Panel 10½"x 19". Depth 13".

The *-hp-* 206A Audio Signal Generator provides a source of continuously variable audio frequency voltage having a total distortion of less than 0.1%. This feature, combined with high stability, flat frequency response, and great accuracy of output voltage, makes it an ideal component for FM station maintenance. Here are some of this instrument's unusual advantages:

Distortion less than 0.1% between 50 cps and 20 kc.

Continuously variable frequency range, covered in 3 bands, micro-controlled dial, effective scale length 47", ball-bearing smoothness for tuning ease.

Output meter monitors output voltage signal with accuracy of at least 0.2 db.

Special low temperature co-efficient frequency determining elements provide high stability and excellent accuracy over long periods of time.

Precision attenuators vary output signal level in 0.1 db steps over 111 db range.

This new *-hp-* generator is convenient to use, compact in size. It can be provided for rack or cabinet mounting, in colors matching your installation.

hp laboratory instruments

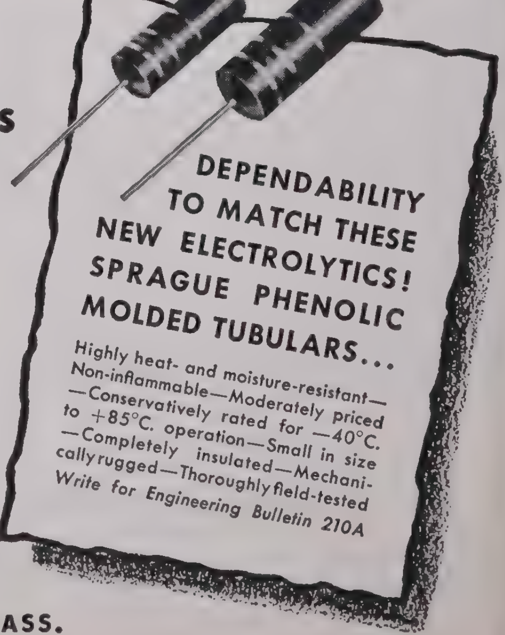
FOR SPEED AND ACCURACY

NEW ELECTROLYTICS
fully dependable
TO 450 VOLTS AT 85°C
SPRAGUE
SPRAGUE
SPRAGUE
ILLUSTRATIONS
ACTUAL SIZE

for TELEVISION'S exacting applications

Designed for dependable operation up to 450 volts at 85°C. these new Sprague electrolytics are a good match for television's severest capacitor assignments. An extremely high stability characteristic is assured, even after extended shelf life, thanks to a special Sprague processing technique. Greatly increased manufacturing facilities are now available.

Your inquiries concerning these new units are invited.



DEPENDABILITY TO MATCH THESE NEW ELECTROLYTICS! SPRAGUE PHENOLIC MOLDED TUBULARS...

Highly heat- and moisture-resistant—Non-inflammable—Moderately priced—Conservatively rated for —40°C. to +85°C. operation—Small in size—Completely insulated—Mechanically rugged—Thoroughly field-tested

Write for Engineering Bulletin 210A

SPRAGUE ELECTRIC COMPANY · NORTH ADAMS, MASS.

SPRAGUE

Capacitors
*Koolohm Resistors

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Most prominent position in any parade is

UP FRONT

featuring

"Built-In" CONSTANT VOLTAGE

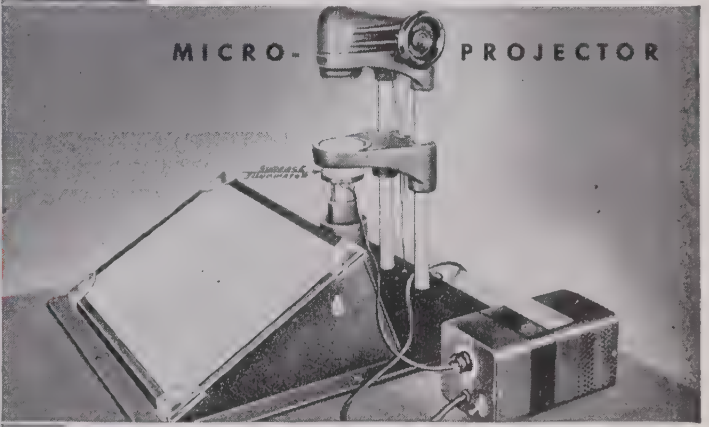
For the Protection of Our Customers

PHOTO ENGRAVING

With power shortages playing hob with line voltages all over the country—isn't it about time that you too joined the parade of manufacturers who are featuring constant voltage as a built-in component in their products.

This preamplifier phasing control section of a medium power, low distortion restricted band audio-amplifier employed in a new printing plate engraving system couldn't operate satisfactorily on available line voltages. Robert H. Rigby Corp., solved the problem with a "built-in" SOLA CONSTANT VOLTAGE TRANSFORMER.

Unstable voltages varied the light output essential for satisfactory operation of this precision instrument. High voltages burned out the light source. "Built-in" SOLA CONSTANT VOLTAGE TRANSFORMERS now provide a constant source of light and enable R. S. Wilder Company to guarantee the life of the lamps.



WHEEL BALANCER

The H. C. Schildmeier Co. says, "We have found the SOLA CONSTANT VOLTAGE TRANSFORMER to be the solution to many of our troubles, by maintaining a constant output voltage to actuate a unit that is direct meter reading" . . . a SOLA CV transformer is a built-in component of every Seal Line Balancer produced by this company.

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BULLETIN KCV-102

A complete, and authoritative treatise on voltage regulation. Write for your copy.

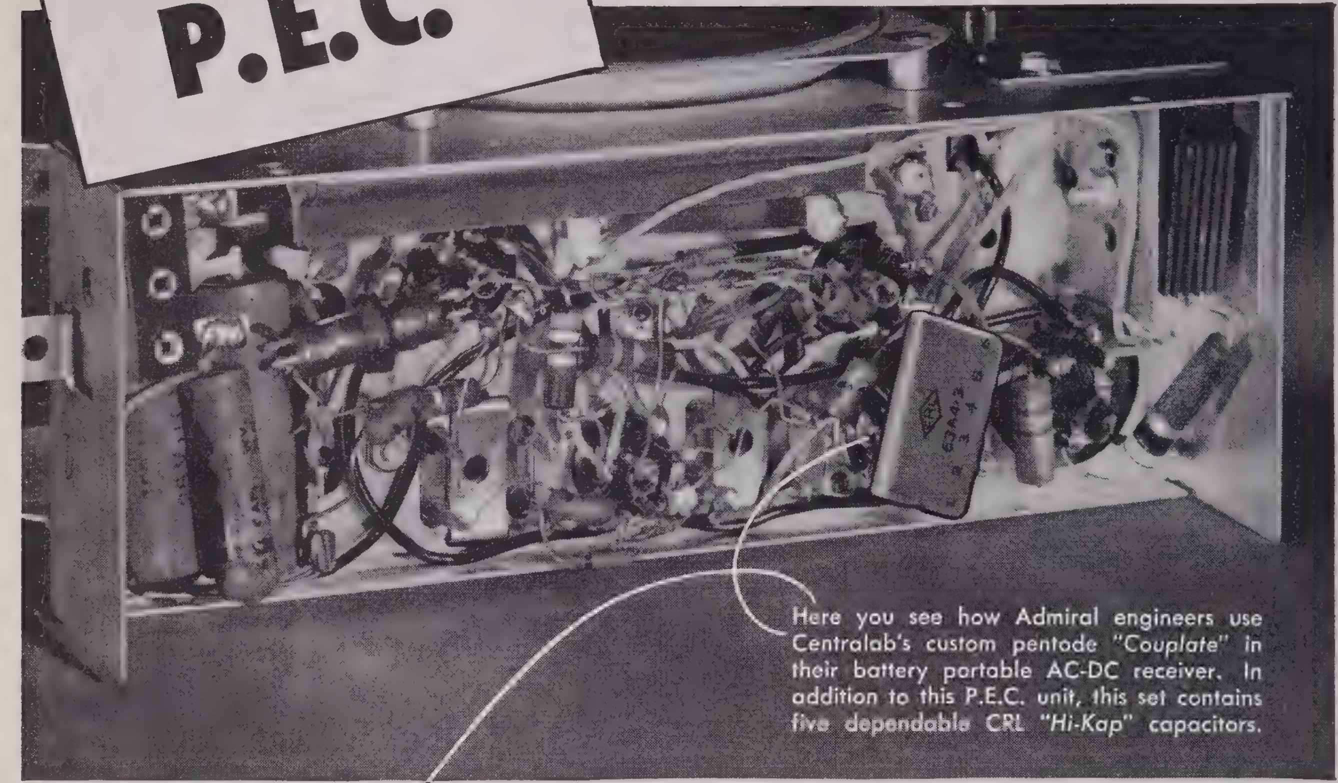
SOLA *Constant Voltage* TRANSFORMERS

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

Manufactured under license by: ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • ADVANCE COMPONENTS LTD., Walthamstow, E., England UCOA RADIO S.A., Buenos Aires, Argentina • M. C. B. & VERITABLE ALTER, Courbevoic (Seine), France

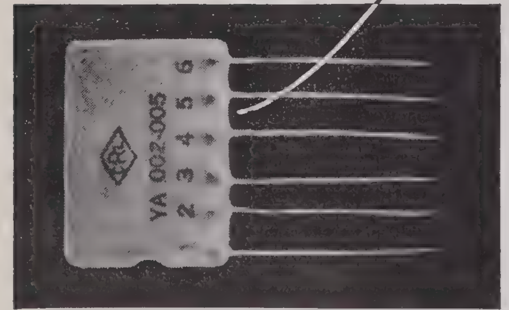
PROGRESS REPORT ON P.E.C.*

How Admiral Radio uses Centralab's *Printed Electronic Circuit* to build finer radios . . . to cut assembling time!

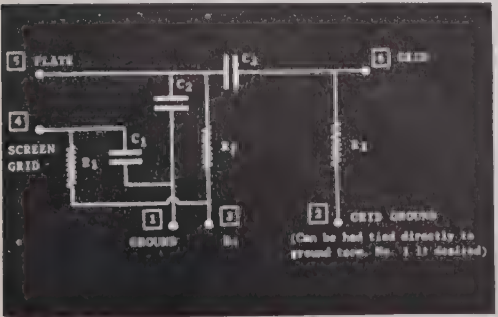


Here you see how Admiral engineers use Centralab's custom pentode *"Couplate"* in their battery portable AC-DC receiver. In addition to this P.E.C. unit, this set contains five dependable CRL *"Hi-Kap"* capacitors.

Chassis courtesy of Admiral Radio Corp.



"COUPLATE" is made of high dielectric Ceramic-X to give long life, low internal inductance, positive resistance to humidity and vibration. A circuit diagram of CRL's *Couplate* is shown below.



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

IMAGINE the time, the space, the material you save by using one unit instead of six. That's just what Centralab's amazing pentode *"Couplate"* is doing for Admiral Radio Corporation, Chicago. This complete interstage coupling circuit combines three resistors and three capacitors into one tiny, dependable P.E.C. unit. *"Couplate"* saves time for Admiral by eliminating many assembling operations. It saves space and material by reducing the number of components needed. What's more it improves performance by minimizing the chance of broken or loose connections.

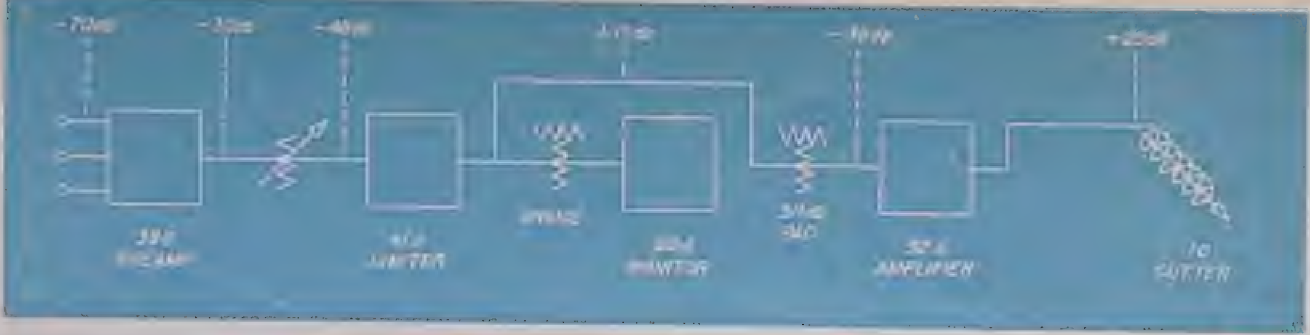
Integral Ceramic Construction: Each *Printed Electronic Circuit* is an integral assembly of *"Hi-Kap"* capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate.

You'll want to see and test this exciting new electronic development. For complete information about *Couplate,* as well as other CRL *Printed Electronic Circuits,* see your nearest Centralab Representative, or write for Bulletin 999.

LOOK TO **Centralab** IN 1949!

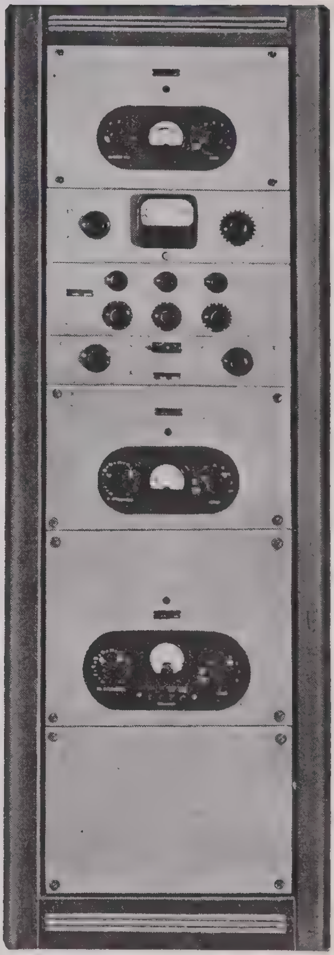
CRL

Division of **GLOBE-UNION INC.,** *Milwaukee*



You're sure

WHEN IT'S 100% PRESTO



Pictured here is an all-Presto single channel recording system. Above is the block diagram, worked out for this equipment by Presto engineers.

WHEN YOU NEED recording or transcription equipment you can't go wrong if you make the complete system 100% Presto. For Presto is the world's foremost manufacturer of recording and transcription equipment and discs. And Presto's experience with countless installations, including all the big ones, will aid you in achieving greater efficiency and trouble-free operation.

The recorder is the 8DG with direct gear drive. The amplifiers are the 39-B three channel preamp, the 41-A limiter, the 92-A 60 watt recording amplifier, and the 89-A monitor.

Multiple channel installations consist of as many duplications of the basic channel as are needed with the addition of switch or patching facilities. When you think of recording, think of PRESTO.

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RECORDING CORPORATION
Paramus, New Jersey
Mailing Address: P.O. Box 500, Hackensack, N. J.
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WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

PERSONALLY CONDUCTED THROUGH THE REVERE MILLS

OFHC COPPER
SPECIAL MIXTURE
SPECIAL MIXTURE

BECAUSE OFHC Copper looks like any other copper, Revere takes great pains to identify it throughout processing, to see it is not lost track of or mixed up with other types. The obvious thing is to mark each piece, which is done, but markings are obliterated by operations such as rolling, and so Revere goes to the length of assigning special personnel to follow each lot of OFHC Copper from one operation to another, watching carefully to be sure each load is kept intact.

In addition, Revere takes full cognizance of the fact that OFHC Copper for radio purposes must have special qualities. In making anodes, it must be deep drawn, and for the feather-edge seal, it must be capable of being rolled or machined down to .002″/.010″. By carefully controlling mill processing, grain size is kept at or below permissible limits. Freedom from oxygen, and from voids, is guaranteed by the method of casting the bars from which we roll the forms required. In addition, there is an operation which results in Revere OFHC Copper being not just commercially free but *nearly absolutely free* of internal and external defects. This great care in producing copper for radio and radar purposes probably accounts for the fact that Revere is a preferred source of supply.

REVERE PRODUCTS AND SERVICES

All Revere Metals are processed with the care and attention required to assure that they meet all metallurgical and physical specifications. Revere supplies mill products in non-ferrous metals and alloys, and also electric welded and lockseam steel tube. An important part of our service to industry is the Revere Technical Advisory Service, which will gladly collaborate with you on specifications and fabrication methods.

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COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
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• Engineers are often surprised to find that metal, plastic or wood parts can be replaced with AlSiMag components at a saving in cost. At the same time they usually gain highly desirable advantages in product performance. It is natural that a product with the many superior advantages of AlSiMag would be expected to be expensive. The basic materials in AlSiMag are costly.

Automatic and efficient manufacture permits quantity production of AlSiMag parts at low prices. Thus, AlSiMag prices are frequently lower than prices of similar parts in cheaper materials which are more expensive to fabricate.

AlSiMag technical ceramic components are custom made for the individual requirement. AlSiMag is the trade name of a large number of ceramic compositions. The physical characteristics of the various compositions are clearly and accurately listed in the AlSiMag Property Chart, sent free on request.

Our engineers will be glad to submit suggestions on design and give you information on cost if you will submit details of your requirements.

Example: A manufacturer replaced a machined part which cost him 33 cents each with an improved AlSiMag component which cost 14 cents each. AlSiMag engineers cooperated in redesigning this component for maximum usefulness to the customer and minimum production cost—That same engineering cooperation is available to you on request.

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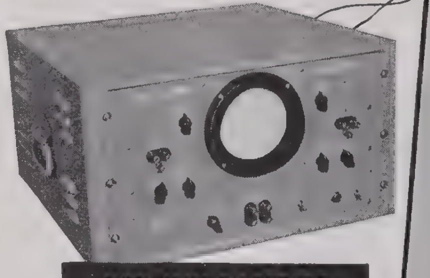
For wider frequency range...top writing rates... increased brightness...it's

DU MONT *High-voltage Oscillography*

The basis is the Type 5RP-A Cathode-ray Tube operating at an accelerating potential up to 29,000 volts maximum. This achieves: (1) Greatly increased brightness; (2) Observation or recording of traces hitherto invisible; (3) Vastly increased writing rates even better than 400 inches per microsecond; (4) Optical magnification by projection lenses such as Du Mont Type 2542. Although deflection sensitivities are slightly less than those of low-voltage cathode-ray tubes, high-voltage oscillographs produce smaller spot size and higher brightness, thereby presenting a finer, better resolved trace.

And here's the Du Mont selection of high-voltage oscillographs:



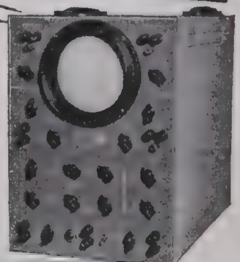
WRITING RATES TO ABOVE 400 IN./MSEC.

Type 281-A: **Devoid of internal deflection amplifiers, there are no frequency response limitations within the ratings of its Type 5RP-A tube. Phenomena have been recorded photographically at writing speeds of 85 inches per microsecond. With external power supply (such as Du Mont Type 286-A), photographic writing speeds of over 400 inches per microsecond may be examined. Recommended when oscillographic needs are extremely specialized or too advanced for standard commercial equipment. An accelerating potential as high as 29,000 volts is available with the Types 281-A and 286-A in combination.**

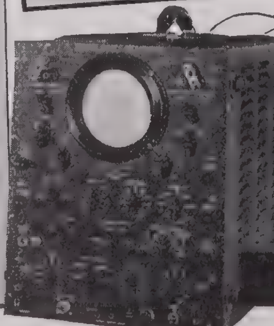
10 CPS to 10 MC

Type 280: **A precision time-measuring oscillograph with range of 10 cps to 10 mc. Sweep speeds as high as 0.25 microsecond/in. are available. Duration of any portion of signal measured on 0.25 microsecond/in. sweep to an accuracy of ±0.01 microsecond. Intervals greater than 5 microseconds read on calibrated dial to accuracy of ±0.1 microsecond. Ready application to precise measurement of duration of waveform of various components in the composite television signal. Accelerating potential adjustable from 7,000 to 12,000 volts. Recordable writing rates up to 63 inches per microsecond, with commercially available equipment.**

Type 250-H: **Covers range from d-c to 200 kc. Potentials containing both d-c and a-c components may be examined. Many special features for general usage include: linear time-base of unusual flexibility; automatic beam control on driven sweeps; internal calibrator of signal amplitude. This is a high-voltage oscillograph with maximum accelerating potential of 13,000 volts. Recordable writing rate of approximately 40 inches per microsecond.**



D-C to 200 KC



20 CPS-5 MC

Type 248-A: **Frequency range of 20 cps to 5 mc. Specifically intended for investigation of pulses containing high-frequency components of recurrent or transient nature. For this purpose it provides these necessary characteristics: High-frequency recurrent sweeps; short-duration driven sweeps; timing markers; signal delay network. Accelerating potentials up to 14,000 volts at recordable writing rate of approximately 69 inches per microsecond.**

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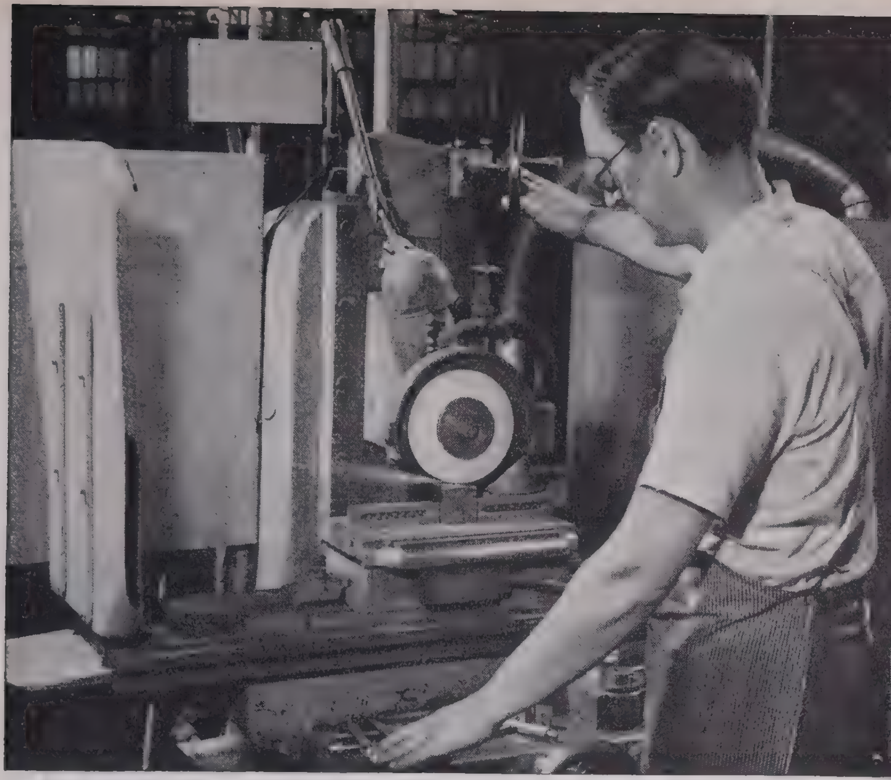
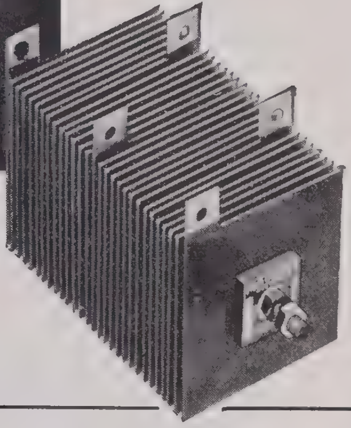
LITERATURE ON REQUEST

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U. S. A.





"...Worked So Well We've Forgotten About It!"

That's the kind of report we like to hear—because it describes a Mallory Magnesium-Copper Sulfide Rectifier Stack which has served *ten years—in daily operation—with minimum maintenance.* Its job—supplying DC current for the operation of a magnetic chuck on each of five surface grinders such as the one shown above. Its performance—it still gives over 90% of its original efficiency.

This is not surprising. Mallory Magnesium-Copper Sulfide Rectifier Stacks are made rugged—practically immune to damage or abuse. Rectification is confined to core of the stack—the outside fins are for heat dissipation only. No liquids, bulbs or moving parts—nothing to give trouble or wear out. And Mallory MgCuS rectifier stacks are more than "the world's toughest rectifiers"—when subjected to abnormal voltage surges, their rectifying junctions are so made that they actually heal themselves.

No wonder millions are in use. Write for more information or for engineering help.

Check These Features:

- ✓ **Proved long life**
- ✓ **Unaffected by high temperatures**
- ✓ **Withstands abuse and accidental short circuits**
- ✓ **Self-healing rectifying junctions**
- ✓ **Constant output over many years**
- ✓ **Resists harmful atmospheric conditions**
- ✓ **Rugged, all-metal construction**
- ✓ **No bulbs, no brushes, no sparking contacts**

MALLORY MgCuS RECTIFIER STACKS ARE THE WORLD'S TOUGHEST RECTIFIERS

P.R. MALLORY & CO. Inc.
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MAGNESIUM-COPPER SULFIDE RECTIFIER STACKS AND POWER SUPPLIES

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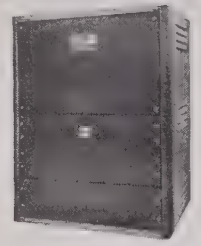
*Reg. U. S. Pat. Off.

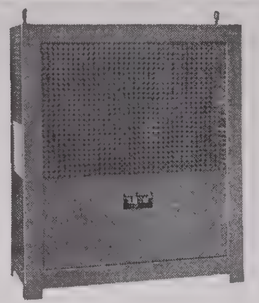
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



3-Phase Regulation

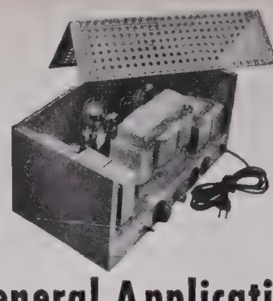
MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
3P15,000	1500-15,000	0.5%
3P30,000	3000-30,000	0.5%
3P45,000	4500-45,000	0.5%

- **Harmonic Distortion on above models 3%. Lower capacities also available.**



Extra Heavy Loads

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
5,000†	500 - 5,000	0.5%
10,000†	1000-10,000	0.5%
15,000†	1500-15,000	0.5%

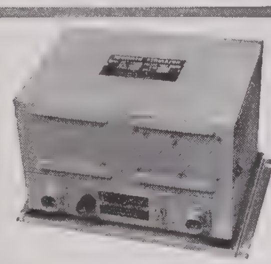


General Application

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
150	25 - 150	0.5%
250	25 - 250	0.2%
500	50 - 500	0.5%
1000	100-1000	0.2%
2000	200-2000	0.2%

SORENSEN

The First Line of standard electronic AC Voltage Regulators and Nobatrons



400-800 Cycle Line

INVERTER AND GENERATOR REGULATORS FOR AIRCRAFT.
Single Phase and Three Phase

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
D500	50 - 500	0.5%
D1200	120-1200	0.5%
3PD250	25 - 250	0.5%
3PD750	75 - 750	0.5%

Other capacities also available

GENERAL SPECIFICATIONS:

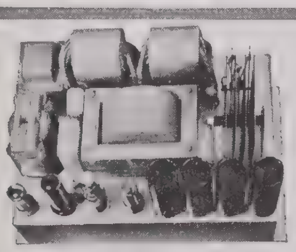
- Harmonic distortion max. 5% basic, 2% "S" models
- Input voltage range 95-125: 220-240 volts (—2 models)
- Output adjustable bet. 110-120: 220-240 (—2 models)
- Recovery time: 6 cycles: † (9 cycles)
- Input frequency range: 50 to 65 cycles
- Power factor range: down to 0.7 P.F.
- Ambient temperature range: —50°C to +50°C

All AC Regulators & Nobatrons may be used with no load.

*Models available with increased regulation accuracy.

Special Models designed to meet your unusual applications.

Write for the new Sorensen catalog. It contains complete specifications on standard Voltage Regulators, Nobatrons, Increvolts, Transformers, DC Power Supplies, Saturable Core Reactors and Meter Calibrators.



The NOBATRON Line

Output Voltage DC	Load Range Amps.
6 volts	15-40-100
12 "	15
28 "	10-30
48 "	15
125 "	5-10

- **Regulation Accuracy 0.25% from 1/4 to full load.**

SORENSEN & CO., INC.
STAMFORD CONNECTICUT

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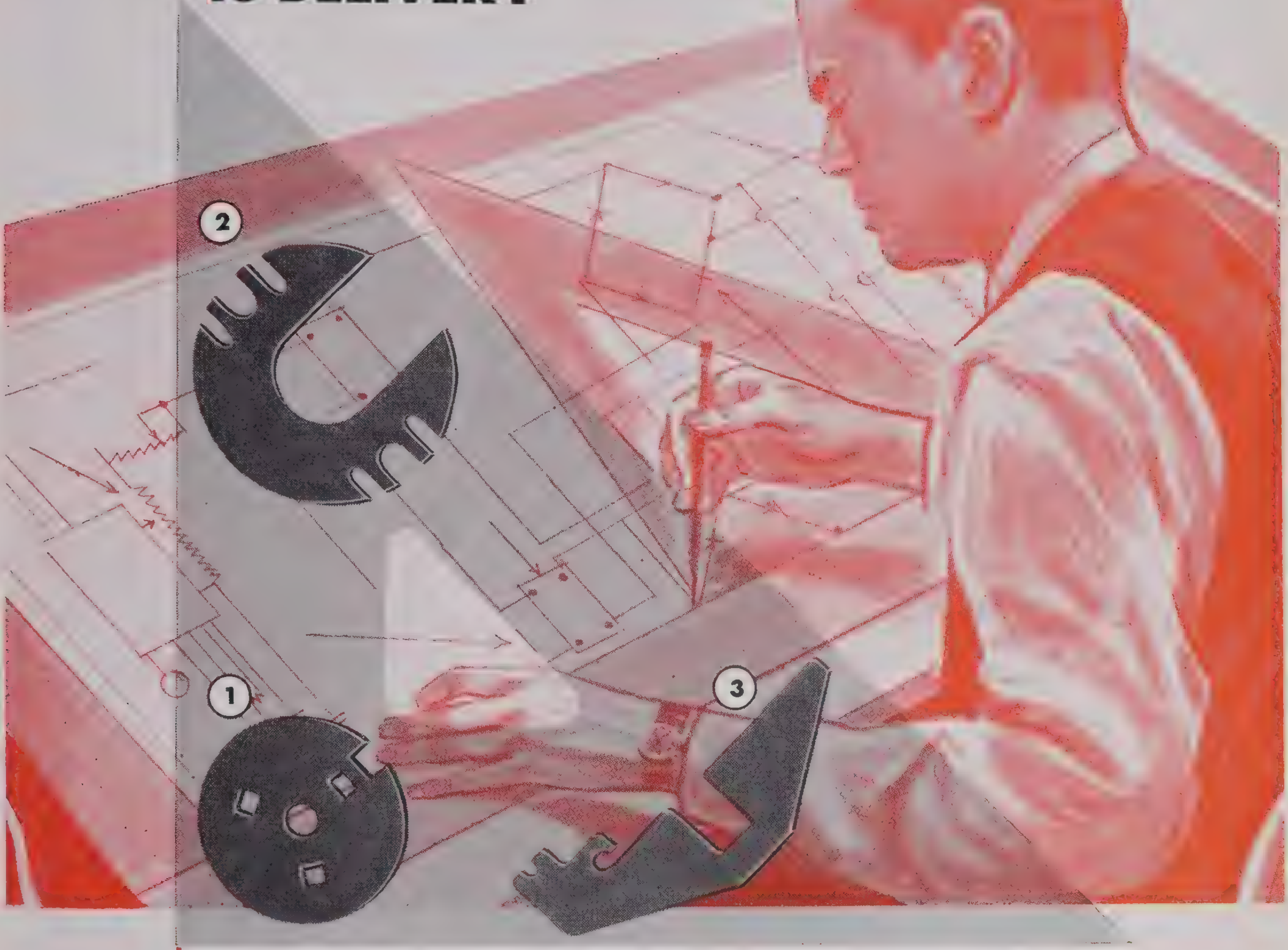

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Whatever your problem, mechanical or electrical, our engineers will be glad to tell you exactly what Taylor can do for you. Write today, sending sketch or blueprint.

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Several avenues of profit are open to you in Arnold Permanent Magnets. You can improve the performance and overall efficiency of equipment. You can increase production speed, and in many cases reduce both weight and size. And most important, you can maintain these advantages over any length of production run or period of time, because Arnold Permanent Magnets are completely quality-controlled through *every* step of manufacture—from the design board to final test and assembly. You'll find them unvaryingly uniform and reliable in every magnetic and physical sense.

It's our job to help you discover and then fully attain these benefits. Arnold Products are available in all Alnico grades and other types of magnetic materials—in cast or sintered forms, and in any size or shape required. Our engineers are at your command—check with our Chicago headquarters, or with any Allegheny Ludlum branch office.

W&D 1298

THE ARNOLD ENGINEERING CO.

Subsidiary of **ALLEGHENY LUDLUM STEEL CORPORATION**

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Optical Microscope IS ANOTHER PRECISION INSTRUMENT EMPLOYED BY SYLVANIA TO ASSURE TUNGSTEN AND SPECIAL ALLOY WIRE PERFECTION ★ ★ ★

Studying the crystals in a magnified section of Sylvania tungsten and special alloy wire is just one more phase of Sylvania's never-ending efforts toward higher and higher quality in radio and electronic tubes.

With the optical microscope shown above, the image of the wire section, magnified as much as 2,000 times, can be projected on the ground glass seen to the left. To the metallurgist who uses this instrument, the sizes, shapes and distribution of the crystals in filamentary and heater wires are extremely important. On the microscope, he examines and studies specific crystal features that are essential for long tube life.

Sylvania's research metallurgy facilities are in constant touch with the Sylvania wire plant in Towanda, Pa., and special alloy wire plant in Warren, Pa., to assure superlative products. Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.

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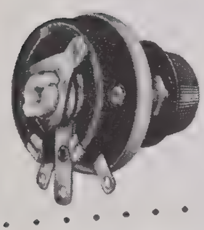
AMONG radio engineers everywhere—there's a definite preference for Ohmite resistance products. These men know—from experience—that Ohmite rheostats, resistors, and chokes provide long, trouble-free service.

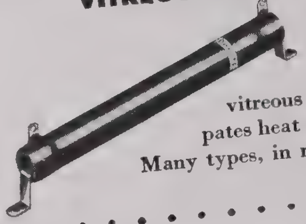
Here's the reason why you get extra performance. Every Ohmite product is designed and constructed to stand up under severe operating conditions. Every unit is built to withstand the effects of shock, vibration, temperature extremes, altitude, and humidity. Make sure you get the benefit of this unfailing dependability. Ask for Ohmite products by name.

CLOSE CONTROL RHEOSTATS



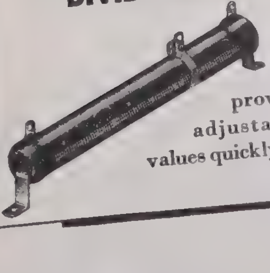
Here is the most extensive line of rheostats offered today . . . 10 sizes, from 25 to 1000 watts, with many resistance values in each size. All-ceramic construction. Windings are locked in vitreous enamel.

VITREOUS ENAMELED RESISTORS



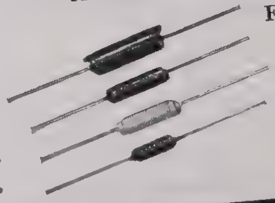
Wire wound on a ceramic core, rigidly held in place, insulated and protected by vitreous enamel. Even winding dissipates heat rapidly—prevents hot spots. Many types, in ratings from 5 to 200 watts.

DIVIDOHM ADJUSTABLE RESISTORS



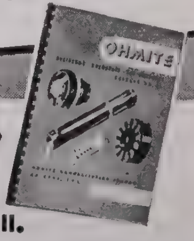
Used as multi-tap resistors or voltage dividers. Narrow strip of exposed winding provides contact surface for the adjustable lug. Gives odd resistance values quickly. Seven ratings—10 to 200 watts.

RADIO FREQUENCY PLATE CHOKES

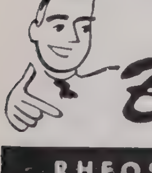


For covering higher frequencies. Single-layer wound on low power factor steatite or molded plastic cores. Seven stock sizes, 3 to 520 megacycles. Two units rated 600 ma; all others 1000 ma.

Write for Catalog 40



OHMITE MANUFACTURING COMPANY • 4862 Flournoy St., Chicago 44, Ill.



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RHEOSTATS • RESISTORS • TAP SWITCHES • CHOKES • ATTENUATORS

MARION . . . helps WEBSTER-CHICAGO

RECORD
LISTEN
VOLUME
OFF
INPUT
record sound on a wire

In designing their superb wire recorder for office and studio recording, Webster-Chicago needed a special meter-type, volume-level indicator for accurate input control. Ruggedness and accuracy were basic requirements. Because Marion has long been noted for fool-proof, trouble-free electrical meters and instruments, it was natural for Webster-Chicago to turn to Marion for this important component.

Marion soon developed a small, specially designed, panel-mounting type of meter for the amazing Webster-Chicago Wire Recorder. In doing so Marion played a vital part in helping Webster-Chicago record the human voice and other sounds on a wire.

When you have a problem that concerns electrical measuring or indicating, we invite you to turn to Marion. We have a long record of success in helping others. And, because we know the name "Marion" means the "most" in meters, we believe we can help you too.

THE NAME "MARION" MEANS THE MOST IN METERS

M·E·I

MARION ELECTRICAL INSTRUMENT COMPANY

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

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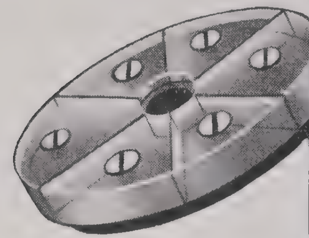
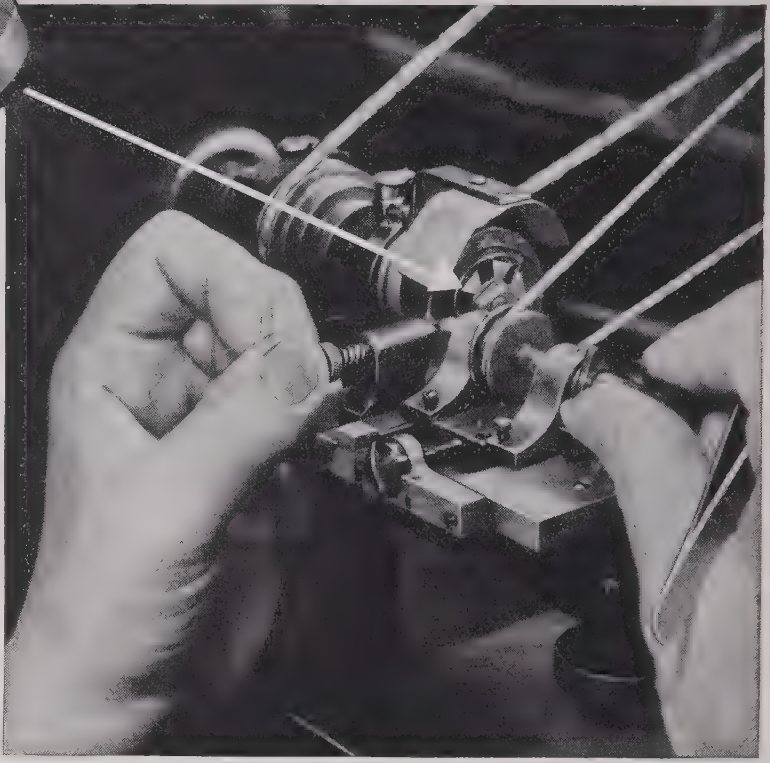
Synthetic Sapphire

for a smooth performance





Synthetic sapphire wheels are unequalled for grinding or burnishing small metal parts to a matchless finish. Because of superior hardness and dimensional stability, sapphire wheels will maintain exact wheel form, eliminating any need for machine adjustment.

LINDE synthetic sapphire has many other properties to recommend it to makers of small but vital parts:

Knoop Hardness	1,525 to 2,000
Chemical Resistance	All Acids
Compressive Strength, psi	300,000
Water Absorption	0.0
Dielectric Constant	7.5 to 10
Thermal Conductivity cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$ at 300 deg. C.	0.010

plus:

Unicrystalline structure—offers no location for immediate wear.

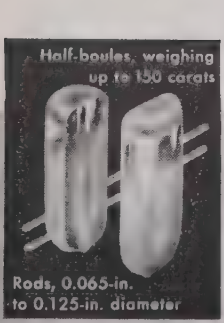
Superior wear resistance.

Extremely low coefficient of friction.

Send for Booklet No. 3A—see how synthetic sapphire can help you with your problems.

Linde Synthetic Sapphire

when the small part is the important part


Half-boules, weighing up to 150 carats
Rods, 0.065-in. to 0.125-in. diameter

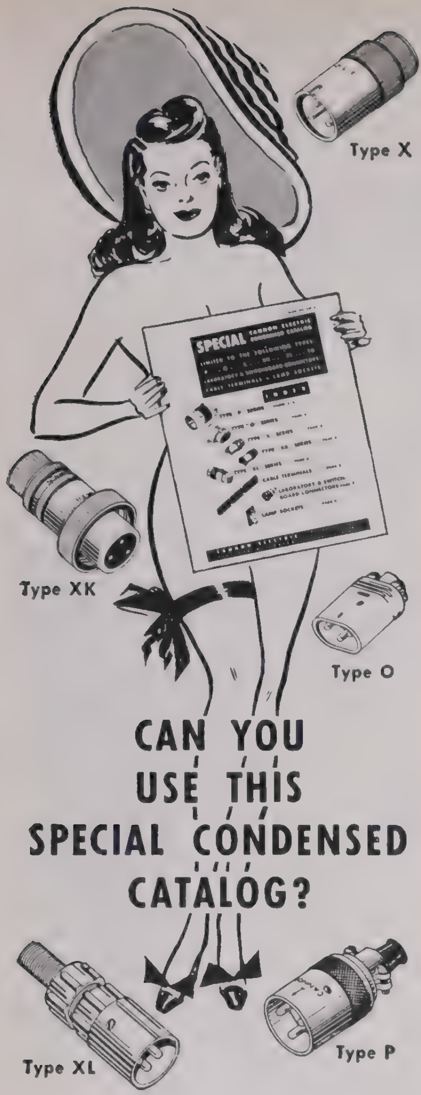
THE LINDE AIR PRODUCTS COMPANY

UNIT OF UNION CARBIDE AND CARBON CORPORATION

30 EAST 42nd STREET • NEW YORK 17 • N.Y. UCC OFFICES IN OTHER PRINCIPAL CITIES

IN CANADA: DOMINION OXYGEN COMPANY, LIMITED, TORONTO

The word "Linde" is a trade-mark of The Linde Air Products Company


Type X
SPECIAL
Type XK
Type O
CAN YOU USE THIS SPECIAL CONDENSED CATALOG?
Type XL
Type P

★ **THE RJC-2 SPECIAL CANNON ELECTRIC** Condensed Catalog covers the electrical connectors sold through our 300-odd regular radio parts distributors for radio and sound applications such as microphones, amplifiers, transmitters, receivers, etc. They include type series "P", "X", "XK" "XL", "TQ". Also shown in the same catalog are Sectional Cable Terminals, Laboratory & Switchboard Connectors and Bayonet Type Lamp Sockets. List prices are given on all items. Address Dept. L-377 for your free copy.

SINCE 1915

CANNON ELECTRIC
Development Company

3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.
IN CANADA & BRITISH EMPIRE:
CANNON ELECTRIC CO., LTD., TORONTO 13, ONT.
WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

C.T.C. Custom-Engineers The Solution To

a tricky feed-thru problem

Feeding an R. F. potential through the wall of a cavity oscillator presented many difficulties. Not only was space at a premium, but extreme changes in humidity, temperature and other service conditions had to be met.

THE ANSWER

C.T.C. 1795B Insulated Feed-Thru Terminals fulfilled every requirement. Design-features like these show you why: *Rugged construction that withstands loosening under vibration or shock . . . approved phenolic insulating material, JAN type LTS-E-4 . . . brass bushings, cadmium plated . . . brass thru-terminals, silver plated for easy soldering.*

SPECIFICATIONS

The 1795B mounts in a ¼″ hole, and has an over-all length of approximately ⅞″. C.T.C. Feed-Thru Terminals are available in additional sizes. The 1795A is similar to the 1795B, but with an over-all length of 1″. Also similar in design and function are X1771A and X1771B, but larger in size and mounting in a ⅜″ hole. Breakdown voltages, at 60 cycles R.M.S., are:

1795A . . . 3800V	X1771A . . . 8200V
1795B . . . 3200V	X1771B . . . 6000V

Catalog No. 200 contains details of C.T.C. standard electric and electronic components, together with full information on our custom-engineering service. Write for it today.

Custom or Standard
The Guaranteed
Components

Swager
Double End Lugs
Split
Short
Turret
Terminal Board

CAMBRIDGE THERMIONIC CORPORATION
456 Concord Avenue, Cambridge 38, Mass.

MACHLETT TUBE USERS GET MORE LIFE, BETTER VALUE

BECAUSE OF MACHLETT EXPERIENCE, SKILL AND "SINCERITY OF SERVICE"

- For over a half century Machlett Laboratories has pioneered and made notable contributions to the development of the electron tube art.

Today, through its modern plant, development laboratories and skilled personnel, it provides the best in tubes and service for Broadcasting and Industrial uses. No matter what your purpose—Broadcasting, Communication or Industrial electronics—you will find a Machlett tube to fill your needs—and fill them well. And, no less important than the tube itself, Machlett Service—valued by tube users for more than 50 years—will give you a new sense of value to apply to your tube procurement problem.

If you want better value—more satisfaction—try MACHLETT.

UHF EQUIPMENT

DEVELOPED • DESIGNED • PRODUCED

1. **DEVELOPMENT** . . from concept of idea to working model
2. **DESIGN** . . . . . . by thoroughly experienced UHF engineers
3. **MANUFACTURE** . . using methods especially suited to UHF work

Specialized UHF knowledge, experience and shop practice enable Lavoie Laboratories to handle every phase of electronic production efficiently and economically.

Precision work and low unit cost are based on these factors developed through years of practical specialization in this field.

. . . LAVOIE PRODUCTS: Frequency Meters—Frequency Standards—Receivers—Transmitters—Antennas and Mounts.

Detailed information and estimates of LAVOIE service are available promptly without cost or obligation.

L U H F

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

Representative RCA types standardized for future equipment designs

Tubes for today and tomorrow

HERE ARE power tubes, phototubes, and c-r tubes to serve the major requirements of equipment manufacturers for a long time to come. The tubes listed are those you can depend on now, and for your future designs.

These RCA types are especially recommended because their wide-spread application permits production to be concentrated on fewer types. Such longer manufacturing runs reduce costs—lead to improved quality and greater uniformity. Resultant benefits are shared alike by the equipment manufacturer and his customers.

RCA Application Engineers are ready to suggest suitable tube types for your design requirements. For further information write RCA, Commercial Engineering, Section LR-42, Harrison, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

Preferred List of RCA Non-Receiving Types

CATHODE-RAY TUBES AND CAMERA TUBES

Kinescopes (Projection)	Camera Types	Oscillograph Types	Monoscope
5TP4	5527	2BP1	2F21
	2P23	3KP1	
	5655	5UP1	
(Directly Viewed)	1850-A		
7DP4			
7JP4			
10BP4			

PHOTOTUBES

Gas Types	1P41	921	927	930
Vacuum Types	922	929		
Multiplier	931-A			

GAS TUBES

Thyratrons	2D21	3D22	884	2050	5563	
Ignitrons	5550	5551	5552	5553		
Rectifiers	3B25 8008	673	816	857-B	866-A	869-B
Voltage Regulators	0A2	0C3/VR105	0D3/VR150			

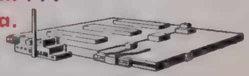
POWER AMPLIFIERS AND OSCILLATORS

TRIODES

(Air-Cooled)	(Forced-Air-Cooled)	(Water-Cooled)
811	6C24	9C21
812-A	7C24	9C27
826	9C22	889-A
833-A	9C25	892
8000	889R-A	
8005	892-R	
8025-A	5588	
	5592	

TETRODES		BEAM TUBES	PENTODES
(Air-Cooled)	(Water-Cooled)	(Air-Cooled)	(Air-Cooled)
4-125A/4D21	8D21	2E24	802
		2E26	
		807	
		813	
		815	
		828	
		829-B	
		832-A	

The world's most modern tube plant . . .
RCA, Lancaster, Pa.



TUBE DEPARTMENT
RADIO CORPORATION of AMERICA
HARRISON, N. J.

F. S. Powell, of WIP, at the RD100 Program Dispatching unit (center panel) presets program connections to Western Electric 10 kw FM transmitter in background and to the 5 kw AM transmitter and Mutual Network.

The Western Electric RD100 *simplifies program switching for WIP*

Chief Engineer Cliff Harris of WIP says:

"Our Program Dispatching System was put into operation just before the political conventions last June. There was not a single hitch. Aided by the most complete and accurate installation data I ever saw, we simply put the equipment in and it worked perfectly. It gave us the needed solid support during one of the busiest periods in our history."

Distributed by Graybar
OFFICES IN 100 PRINCIPAL CITIES

At WIP, Philadelphia, the Western Electric RD100 Program Dispatching System has provided an ideal solution to the ever-present problem of program switching.

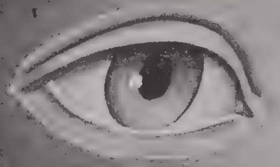
By simply pushing one button, the operator simultaneously switches preset program connections between the seven studio program sources and the three output trunks to the AM transmitter, FM transmitter and Mutual Network. Circuit connections are preset at leisure in advance of station breaks.

Equipment is complete in WIP's unit for three additional inputs and three additional outputs whenever needed—a total of ten input and six output channels, which can be connected in any combination.

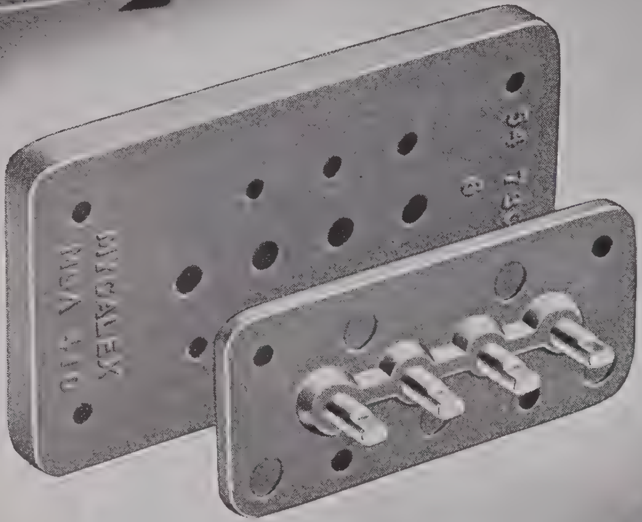
For further information on the RD100 Program Dispatching System, call your Graybar Broadcast Representative or write to Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.

Western Electric
—QUALITY COUNTS—

DISTRIBUTORS: IN THE U.S.A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Company, Ltd.



See why Leaders in TELEVISION choose MYCALEX 410 insulation



PHILCO
uses these
MYCALEX 410
molded parts
in its
TELEVISION
TUNER

In television seeing is believing . . . and big name makers of television sets are demonstrating by superior performance that MYCALEX 410 molded insulation contributes importantly to faithful television reception.

Stability in a television circuit is an absolute essential. In the station selector switch used in receivers of a leading manufacturer, the MYCALEX 410 molded parts (shown here) are used instead of inferior insulation in order to avoid drift in the natural frequency of the tuned circuits. The extremely low losses of MYCALEX at television frequencies and the stability of its properties over extremes in temperature and humidity result in dependability of performance which would otherwise be unattainable.

Whether in television, FM or other high frequency circuits, the most difficult insulating problems are being solved by MYCALEX 410 molded insulation . . . exclusive formulation and product of MYCALEX CORPORATION OF AMERICA. Our engineering staff is at your service.

Specify MYCALEX 410 for:

1. *Low dielectric loss*
2. *High dielectric strength*
3. *High arc resistance*
4. *Stability over wide humidity and temperature changes*
5. *Resistance to high temperatures*
6. *Mechanical precision*
7. *Mechanical strength*
8. *Metal inserts molded in place*
9. *Minimum service expense*
10. *Cooperation of MYCALEX engineering staff*

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J. *Executive Offices,* 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For Perfected Large-Size Home Projection–PROTELGRAM

The 2½″ magnetic projection triode 3NP4 has a face as small as a compact and is only 10½″ long.

HERE'S THE OPPORTUNITY THAT MANUFACTURERS OF TELEVISION RECEIVERS HAVE BEEN AWAITING!

10 SIGNIFICANT FEATURES

1. Flat 16″ x 12″ non-reflecting picture provides fatigueless viewing from less than 5 feet and upward!
2. Wide-angle visibility — *square corners.*
3. True photographic black and white picture quality—no discoloration.
4. Compact unit—suitable for table model cabinets.
5. Long-life, low-cost picture tube.
6. Manufacturers can most economically extend their product range into projection television by adapting their 10″ EM chassis for use with PROTELGRAM.
7. Easy to service.
8. High contrast ratio and broad gray tone range.
9. Simple optical adjustment system.
10. *Quality built* after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated high-voltage supply unit, making possible large-size home projection. More than ten years of exhaustive research resulted in this ideal system for reproducing a projected picture. The optical components are designed to produce perfected projection for a 16″ x 12″ image, the optimum picture size for steady, distant observation and also for *proper viewing at less than 5 feet.*

Other NORELCO products include standard 10″ direct-viewing tubes and special-purpose cathode-ray tubes for many applications.

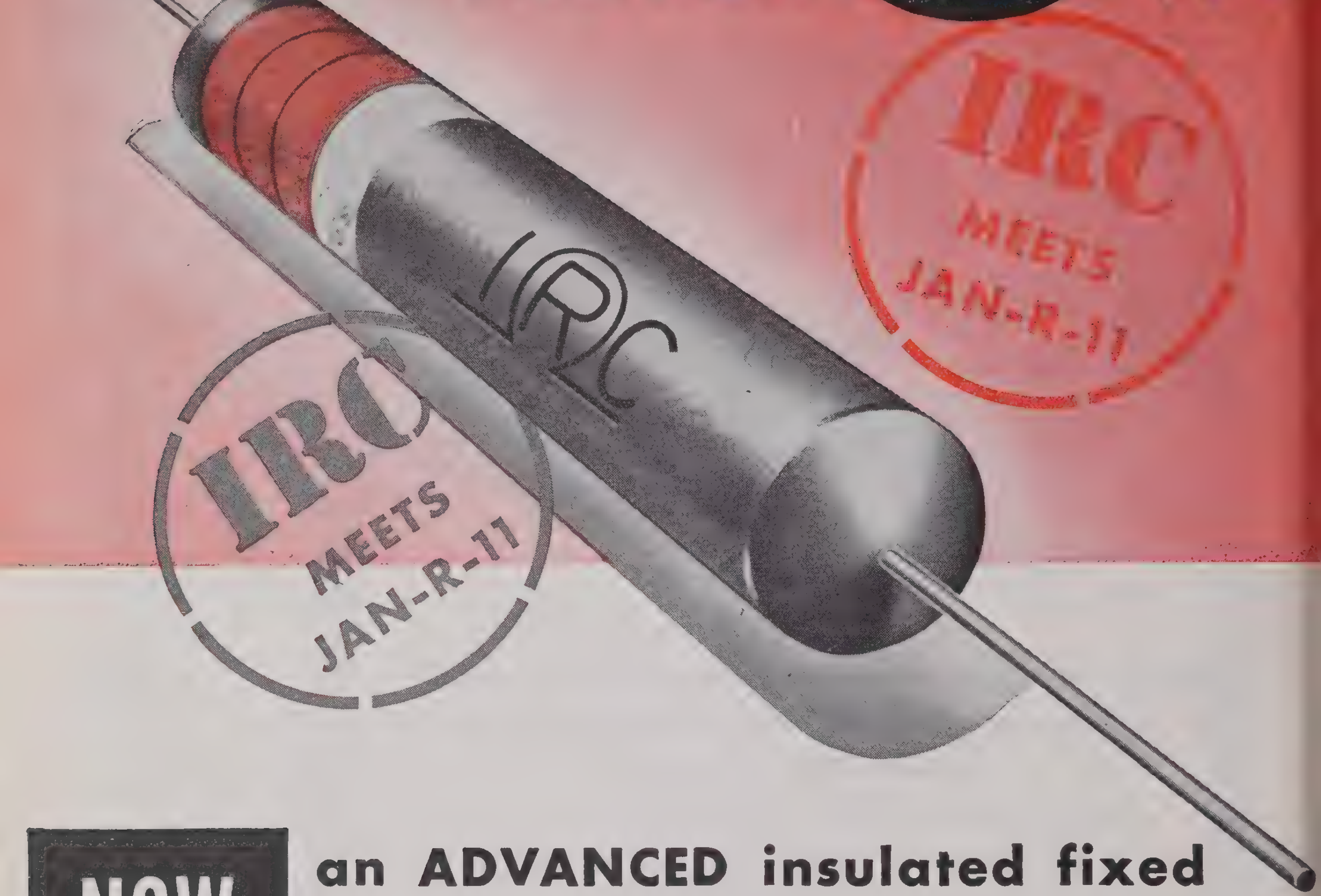
NORTH AMERICAN PHILIPS COMPANY, INC.
Norelco

PROTELGRAM IS PICTURE PERFECTION IN PROJECTION

NORTH AMERICAN PHILIPS COMPANY, INC.
DEPT. TP12, 100 EAST 42nd STREET, NEW YORK 17, N. Y.

IN CANADA: PHILIPS INDUSTRIES LTD., 1203 PHILIPS SQUARE, MONTREAL ★ EXPORT REPRESENTATIVE: PHILIPS EXPORT CORPORATION, 100 EAST 42ND STREET, NEW YORK 17, N. Y.

This NEW IRC type



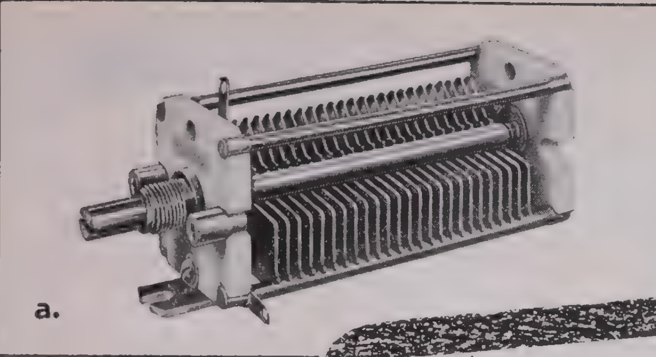
NOW an ADVANCED insulated fixed composition resistor that offers new opportunities to radio, television, electronic and electrical engineers.

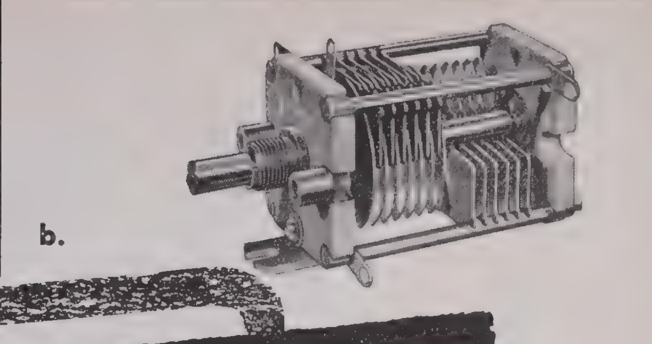
At desks and drawing boards across the country resistor requirements are being reviewed in the light of this *advanced* resistor. Quiet huddles in engineering departments and research labs are rapidly disclosing present performance standards for fixed composition resistors to be obsolete.

The new IRC Type BT resistor *meets* JAN-R-11 specs. At ⅓, ½, 1 and 2 watts, the *new* IRC Type BT is an *advanced* resistor in every respect.

You may specify this *advanced* IRC resistor immediately. It is in production now, with hundreds of thousands coming off production lines daily.

T *means* **B**etter **T**echnically **BTS** *means* **B**eats **T**oughest **S**pecs **BTR** *means*


a.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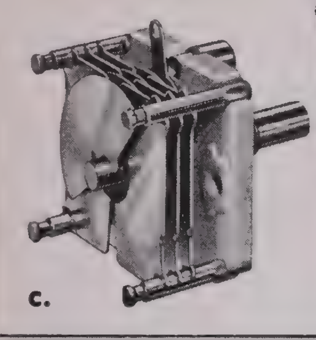
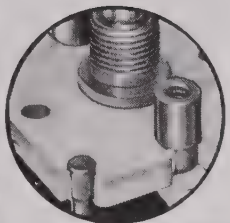
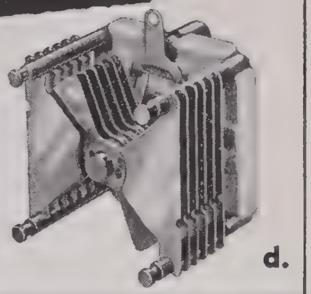

c.

CERAMIC SOLDERED . . .



FOR STABILITY
AND STRENGTH


d.

Announcing the new JOHNSON 167 VARIABLES

BETTER FOR UHF - VHF - LF

With the introduction of this new line of air variables, JOHNSON brings you many important design advantages never before available.

Outstanding of these is the use of perfected ceramic soldering which assures absolute — and permanent — rigidity and strength, absolute — and permanent — maintenance of capacities!

There are no eyelets, nuts or screws to work loose, causing stator wobble and fluctuations in capacity. JOHNSON ceramic soldering leaves a bond which is stronger than the rugged steatite end plates themselves. There's nothing to come loose, because the stator terminals, mounting posts and rotor bearings are ceramic soldered!

Silent operation on the highest frequencies is assured with a split sleeve tension bearing that also prevents fluctuations in capacity.

These new variables are ideal for peak efficiency even under the severest conditions, such as portable — mobile operation. They are available in .030" and .080" spacings.

Two sets of stator contacts are provided for connecting components to either side of condenser without appreciably increasing inductance of the circuit. New bright alloy plating is used. It has high corrosion resistance, is easily soldered and possesses lower electrical resistance than other common platings.

These variables are available for all types of communications equipment having tuned circuits operating as high as 500 mc.

Features

1. Ceramic soldered for stability and strength
2. Soldered plate construction, heavy .020" plates, new bright alloy plating
3. Beryllium copper contact spring, silver plated
4. Split sleeve rotor bearings — no wobble to shaft
5. Steatite end plates
6. Long creepage paths
7. Low minimum capacity — maximum tuning range
8. Small size — end plate only 1⅜" square

Other capacities and spacings available on special order.

ⓐ SINGLE SECTION VARIABLES

.030" Spacing

Cat. No.	Cap. Per Section Max.	Min.	Length Behind Panel
167-101	11	2.8	15/16
167-102	27	3.5	1-9/64
167-103	51	4.6	1-7/16
167-104	75	5.7	1-¾
167-151	99	6.8	2-7/32
167-152	202	11.6	3-33/64

Also Available In .080" Spacing

ⓑ DUAL SECTION VARIABLES

.030" Spacing

Cat. No.	Cap. Per Section Max.	Min.	Length Behind Panel
167-501	27	3.5	1-13/16
167-502	51	4.6	2-27/64
167-503	99	6.8	3-⅝

Also Available In .080" Spacing

ⓒ DIFFERENTIAL VARIABLES

.030" Spacing

Cat. No.	Cap. Per Section Max.	Min.	Length Behind Panel
167-301	11	2.8	15/16
167-302	27	3.5	1-9/64
167-303	51	4.6	1-7/16

Also Available In .080" Spacing

ⓓ BUTTERFLY VARIABLES

.030" Spacing

Cat. No.	Cap. Per Section Max.	Min.	Length Behind Panel
167-201	10.5	2.8	1-3/64
167-202	26	4.3	1-7/16
167-203	51	6.5	1-15/16

Also Available In .080" Spacing

Write For NEW JOHNSON 167 VARIABLE CATALOG

JOHNSON . . . *a famous name in Radio!*

E. F. JOHNSON CO., WASECA, MINNESOTA

Investigate this Opportunity

To join the staff of one of the largest research organizations in the country devoted exclusively to

VACUUM TUBE RESEARCH

Working conditions are ideal in these laboratories which are located in the New York Suburb of Orange, New Jersey. Your associates will include men of many years experience in vacuum tube research and development.

This rapidly expanding organization is devoted to both commercial and military research. It is a division of one of the oldest vacuum tube manufacturers in America. Security and stability for the years to come are assured. You will have an opportunity to gain experience with the different kinds of vacuum tubes, receiving, power, cathode ray, sub-miniature, micro-wave, radial beam and various special types.

If you can qualify as a

PHYSICIST
ELECTRICAL ENGINEER
CIRCUIT TECHNICIAN
VACUUM TUBE TECHNICIAN

write at once to

RESEARCH DIVISION
NATIONAL UNION RADIO CORPORATION
350 Scotland Rd.
Orange, New Jersey

PHILCO

To maintain the Philco tradition of progressive research and development in the electronic field an ever increasing staff of engineers and physicists has been employed over the last two decades. Continuing expansion of Philco's engineering and research activities is producing excellent opportunities for engineers and physicists.

The scope of the work in the Philco laboratories includes basic research on the theory of semiconductors; vacuum tube research and design, including cathode ray tubes; and the design of special circuits, radio, television, television relay and radar systems.

IF YOU ARE INTERESTED IN YOUR OPPORTUNITY AT PHILCO,

WRITE . . . Engineering Personnel Director
Philco Corporation
Philadelphia 34, Pa.

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. . . .

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

ELECTRONIC ENGINEERS—ELECTRONIC TECHNICIANS

Men with production, inspection or redesign experience preferred. Direct inquiries to SLX-1, P.O. Box 5800, Albuquerque, New Mexico.

TELEVISION ENGINEERS

Well established electronics manufacturer, located in suburban New York City area needs high grade television development engineers. Company is expanding its television activities and seeks capable men with background sufficiently complete to merit responsible positions. Send details to Chief Engineer, Box 536.

PROJECT ENGINEER

Stamford firm engaged in development and research work with government agencies requires project engineer with technical and practical background in UHF radar work. Salary open depending upon background. Company is young and growing with promising future for able engineers in this kind of work. Box 538.

ELECTRONIC ENGINEERS

College graduates with 3-5 years of development engineering experience in circuit design. Well versed in magnetic circuits, non-linear circuit operation and electronic theory. Send resume and all particulars to Personnel Department, General Precision Laboratory, Inc., Pleasantville, New York.

RESEARCH AND DEVELOPMENT ENGINEERS

Engineers with considerable experience in RF and UHF circuits wanted by large, well established radio company in New York area. Send resume of education and experience to Box 539.

GRADUATE PHYSICIST

Graduate physicist or electronic engineer with good background in gaseous conduction wanted by established New England radio tube manufacturer, for development work on gas filled tubes. Box 540.

MATHEMATICIANS, ENGINEERS, PHYSICISTS

Men to train in oil exploration for operation of seismograph instruments, computing seismic data, and seismic surveying. Beginning salary $250.00 to $300.00 per month depending upon background. Excellent opportunity for advancement determined by ingenuity and ability. The work requires changes of address each year; work indoors and out; general location in oil producing locations. Send resume and include snapshot to National Geophysical Co., Inc., 8800 Lemmon Ave., Dallas 9, Texas.

(Continued on page 52A)

Your enjoyment climbs to new altitudes through radio and television achievements of RCA

Radio and Radar Development and Design Engineers

RCA Victor Division has openings for men with experience in:

- **Mobile Transmitters**
- **Radar**
- **Audio Communications and Supersonics**

Please furnish complete resume of experience to:

Employment Manager
Camden Personnel Division
RCA Victor Division
Camden, New Jersey

WANTED SENIOR ENGINEERS, PHYSICISTS

Key positions open for top flight electronic men with 5 or more years experience in theoretical analysis of:

- RADAR SYSTEMS
- MISSILES
- MICROWAVES
- COMPUTERS
- COMMUNICATIONS

send resume or
phone Personnel
Manager

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WANTED PHYSICISTS ENGINEERS

Engineering laboratory of precision instrument manufacturer has interesting opportunities for graduate engineers with research, design and/or development experience on radio communications systems, Servomechanisms (closed loop), electronic & mechanical aeronautical navigation instruments and ultra-high frequency & microwave technique.

WRITE FULL DETAILS
TO
EMPLOYMENT SECTION

SPERRY GYROSCOPE COMPANY
DIVISION OF SPERRY CORP.
Marcus Ave. & Lakeville Rd.
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Advanced
Home Study and Residence Courses in Practical Radio-Electronics and Television.
Approved for Veteran Training

ENGINEERS – ELECTRONIC

Senior and Junior, outstanding opportunity, progressive company. Forward complete résumés giving education, experience and salary requirements to

Personnel Department
MELPAR, INC.
452 Swann Avenue
Alexandria, Virginia

POSITIONS OPEN

(Continued from page 50A)

ELECTRONICS ENGINEER

Well known, 40 year old manufacturer of electrical and electronic instruments wants research engineer experienced in design of radio electronic apparatus at high frequencies, for the development of military and civilian test equipment. Box 542.

PHYSICISTS—ENGINEERS

Opportunities for physicists and electronic engineers at the Naval Ordnance Test Station, P.O. China Lake, California. Applicants should have college degree or equivalent, plus professional experience. Especially desired are applications from persons with experience in design and development of microwave radar components. Send application form 57 to Placement Officer U.S.N.O.T.S., Inyokern, P.O. China Lake, California.

ENGINEERS

A young rapidly expanding mid-western research laboratory has openings for the following types of personnel:
(1) ELECTRONIC DESIGN ENGINEERS—Experience circuit design enginees wanted for indicator timing circuit development.
(2) SERVO DESIGN ENGINEERS OR PHYSICISTS—Experience required for the development airborne computor equipment.

Top pay offered to those capable of project responsibility. Local university offers graduate courses in servo and computer design, and applied mathematics. Send complete resume. Our Engineering Dept. knows of this announcement. Box 544.

ELECTRONIC ENGINEERS—PHYSICISTS

A leading electronics company in Los Angeles, California offers permanent employment to persons experienced in advanced research and development. State qualifications fully. Box 545.

ELECTRONIC ENGINEER

An opportunity for a man with considerable experience to head a small development and engineering group in a growing company located in Chicago. Pulse experience a necessity and a background of work with nuclear radiation instruments and nuclear detectors very desirable. Please give full details. Box 546.

RADIO AND TELEVISION ENGINEERS

The Industry Service Laboratory (formerly License Laboratory), New York, has several positions open for Senior and Junior engineers having qualifications for development and consultation work in television and radio. Good technical education and some experience required. Interesting work, broadening experience, and wide contacts. Write fully to Director, Industry Service Lab., RCA Laboratory Division, 711 Fifth Ave., New York 22, N.Y.

CRYSTAL ENGINEER

Manufacturer of Piezo electric crystals desires experienced engineer familiar with quartz oscillating crystals and their applications to radio frequency control. Write full details. Box 548.

SENIOR ENGINEER

with outstanding academic and practical experience and executive ability in the field of cathode ray tube display and indicators for radar systems, wanted by long established corporation. Knowledge of all types of projection systems and present types of service equipment desirable. Write, giving resume of education, experience, age and salary.

FREED RADIO CORPORATION
200 Hudson Street, New York, N.Y.

WANTED ELECTRONIC ENGINEERS AND PHYSICISTS

Excellent opportunities for graduates with research, design, and/or development experience in Communications and aerial navigation systems including direction finders, radar, FM, television, micro-wave.

Write complete details regarding education, experience and salary desired.

To Personnel manager
Federal Telecommunication Laboratories
500 Washington Ave.
Nutley, New Jersey

POSITIONS OPEN

RESEARCH AND DEVELOPMENT ENGINEERS

Wanted for advanced research and development. Should have extensive experience on analysis of electronics systems in the fields of microwaves, missiles, radar, servomechanisms communications, navigational devices. Outstanding ability in E.E. or physics required. Please furnish complete resume, salary requirements and availability to: Personnel Manager, W. L. Maxson Corporation, 460 West 34th Street, New York, N.Y.

ELECTRICAL ENGINEER

Nationally known Chicago company is in need of high grade, experienced electrical engineer. Must be a college graduate with either a B.S. or E.E. degree, with high scholastic record. Should have from 2 to 5 years experience in electronics, preferably with a minimum of two years in the design of audio amplifiers. In reply give all particulars and state expected salary. Address Box 549.

DESIGN AND DEVELOPMENT ENGINEER

Design and development engineer to take charge of engineering and development of receiving antennae and associated equipment. U.H.F. experience desirable. Upstate New York manufacturer. Reply giving age and qualifications to Box 450.

(Continued on page 54A)

ZENITH RADIO CORPORATION needs Research and Development Engineers and Physicists

Project, senior and junior engineers and physicists are required for prosecution of several very interesting developments. Openings exist for men experienced in various aspects of radio and television receiver and transmitter development, in radar, and in applications of electronics to ordnance problems. *Salaries commensurate with experience and ability.*

WRITE: Director of Research
Zenith Radio Corp.
6001 W. Dickens Ave.
Chicago 39, Illinois

Electronic Engineers

Bendix Radio Division
Baltimore, Maryland
manufacturer of
RADIO AND RADAR EQUIPMENT
requires:

PROJECT ENGINEERS

Five or more years experience in the design and development, for production, of major components in radio and radar equipment.

ASSISTANT PROJECT ENGINEERS

Two or more years experience in the development, for production, of components in radio and radar equipment. Capable of designing components under supervision of project engineer.

Well equipped laboratories in modern radio plant . . . Excellent opportunity . . . advancement on individual merit.

Baltimore Has Adequate Housing

Arrangements will be made to contact personally all applicants who submit satisfactory resumes. Send resume to Mr. John Siena:

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION
Baltimore 4, Maryland

Wanted
Design Engineers Physicists

Men with a college degree and two to four years design experience should investigate the opportunities offered by the Collins Radio Company. This well-recognized manufacturer of radio equipment has a limited number of positions available for qualified engineers and physicists. These men will work on the design and development of broadcast, communications, radar, and electronic circuits in the design and research departments. Give present position, nature of work, experience, and education in first letter.

ADDRESS DEPARTMENT EP
COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

A Ballantine

ELECTRONIC VOLTMETER

For every requirement

ALL MODELS HAVE THE
SIMPLIFIED
LOGARITHMIC
SCALE

STANDARD
Model 300

Model 304
R-F
VOLTMETER

Ideal for the *Accurate* measurement of AC voltages in the Audio, Supersonic, Carrier Current and Television ranges.

Use of Logarithmic voltage scale assures uniform accuracy of reading over whole scale while permitting range switching in decade steps.

Each Voltmeter equipped with an output jack so that the instruments can be used as a high-gain stable amplifier.

SPECIFICATIONS

MODEL 300

RANGE—.001 to 100 volts.
FREQUENCY—10 to 150,000 cycles.
ACCURACY—2% at any point on scale.
AC OPERATION—110-120 volts.

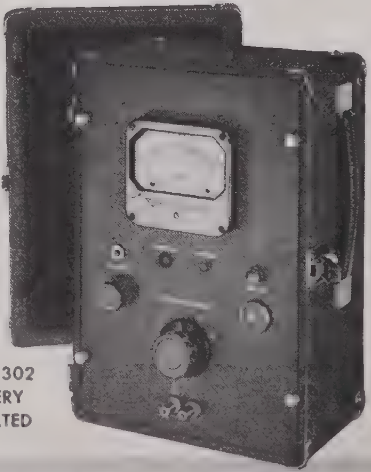
MODEL 304

RANGE—.001 to 100 volts.
FREQUENCY—30 c.p.s. to 5.5 megacycles
ACCURACY—0.5 DB.
AC OPERATION—110-120 volts.

MODEL 302

RANGE—.001 to 100 volts
FREQUENCY—5 to 150,000 cycles.
ACCURACY—2% at any point on scale.
DC OPERATION—self-contained batteries.

Send for Bulletin for further description



Model 302
BATTERY
OPERATED

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.

POSITIONS OPEN

(Continued from page 53A)

SALES ENGINEER

Several territories open east of Rocky Mountains for alert, experienced sales engineer representative capable of selling and installing FM two-way radiotelephone systems for mobile operations. Nationally advertised product. Exceptional opportunity for right man. Send detailed qualifications, education, past experience and territory desired. Radiotelephone Operators License, 1st or 2nd class preferred. Must have had previous experience in FM radiotelephone. Reply Box 451.

SCIENTISTS AND ENGINEERS

Wanted for interesting and professionally challenging research and advanced development in the fields of microwaves, radar, gyroscopes, servomechanisms, instrumentation, computers, and general electronics. Scientific or engineering degrees required. Salary commensurate with experience and ability. Direct inquiry to Manager, Engineering Personnel, Bell Aircraft Corporation, P.O. Box 1, Buffalo 5, New York.

RADIO PROJECT ENGINEER

Graduate engineer; 5 years recent experience design and development oscillator and amplifier circuits in VHF and UHF ranges. Familiar theoretical concepts and calculations circuit components, as well as practical design and layout work. Must have initiative and supervisory ability. Federal Manufacturing & Engineering Corporation, Brooklyn 5, N.Y.

AERO DYNAMICIST ENGINEERS

Aero Dynamicist engineers wanted to work on the design of Analog computers, to simulate the flight characteristics of specific aeroplanes. 3 years experience in stability and control essential. Knowledge of servomechanisms dynamics of free flight and applied mathematics desirable. Apply in person, or submit resume to Personnel Dept. Curtiss Wright Corp., Propeller Division, Route 6, Caldwell Township, New Jersey.

ELECTRONICS ENGINEERS

Top flight engineers. Must have 10 years design and development experience on servomechanisms and amplifiers, circuits and equipment layout. Apply in person or submit complete resume to Personnel Dept., Curtiss Wright Corp., Propeller Division, Route 6, Caldwell Township, New Jersey.

ELECTRICAL ENGINEER

Opening for a man who has the ability to teach advanced electronic circuits and theory, frequency modulation and television. Should eventually teach course in ultra-high frequency techniques and electric wave phenomena and pulse systems. Reply to: Director of Academic Administration, 1020 North Broadway, Milwaukee 2, Wisconsin.

SOUND ENGINEER

For large radio and television manufacturer in Chicago area. Experience in loud speaker design, audio circuits, and acoustics necessary. Fine opportunity for advancement. Please write giving full particulars. Box 552.

(Continued on page 55A)

Positions Open

PROFESSOR

Professor of communications engineering needed for fall 1949 by southeastern university. Will be in charge of graduate work and research activities. $6000.00 for nine months with extra income for summer teaching. Must have Ph.D. or D.Sc. degree. Write Box 553.

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ENGINEER

Engineer. 28. B.S.E.E. Columbia, also business degree. 3 years responsible business experience. Best references. New York area preferred. Call Lu. 8-9164 mornings or write. Box 182 W.

SALES ENGINEER OR EXECUTIVE ASSISTANT

Young, aggressive, hard-hitting design and development engineer invites inquiries from firms having need for addition to sales engineering staff or assistant to top executive. Thorough background of research, design and supervision in measurement apparatus; receivers, transmitters and audio equipment. Capable of handling engineering, purchasing, production, inspection and personnel. Prefer New York City location. Box 187 W.

PHYSICIST

Twenty-seven year old graduate physicist and mathematician with experience in control circuits desires either foreign or domestic employment. Box 197 W.

BROADCAST ENGINEER

Nine years experience. Now employed as assistant chief engineer 5 KW AM 50 KW FM, major network station, directional antennas. Desires chief engineer position or transmitter supervisor in east. Best references. All offers considered. Box 199 W.

ENGINEERING—ADVERTISING

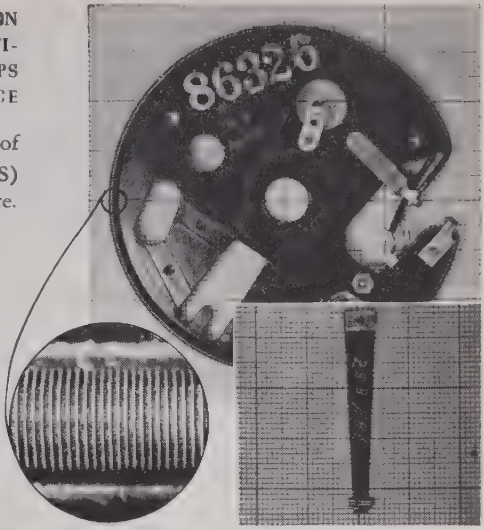
Hard-hitting advertising executive who can talk an engineer's language.

A.B., M.A., plus 3 years electrical engineering. Last 4 years with top electrical corporation creating sales campaigns, ad-

(Continued on page 56A)

NEY PRECIOUS METALS IN INDUSTRY

NEY-ORO #28B BRUSH CONTACT ON ADVANCE* WIRE WOUND POTENTIOMETER RUNS 4,300,000 SWEEPS WITH NO CHANGE IN RESISTANCE



Mandrel and brush shown 40% full size. Section of mandrel 6⅔ x magnification.

Examine these unretouched photographs of mandrel (wound with Advance* #36 B&S) and brush adjusted for 50 gms pressure. There is no appreciable wear on the winding after 4,300,000 sweeps of the brush and the wear on the brush is less than .008". Throughout the test there was no perceptible change in resistance. Truly a remarkable performance when you consider the additional fact that the test was conducted at a speed of 37.5 cycles (75 sweeps) per minute, considerably faster than normal operation. The test was conducted by a leading manufacturer of precision equipment and the complete test data is available on request. It is, we believe, further convincing evidence of the interesting possibilities offered by the use of Ney Precious Metal Alloys in industrial and scientific applications.

Write or phone (Hartford 2-4271) our Research Department.

*Reg. T. M. of D-H Co.

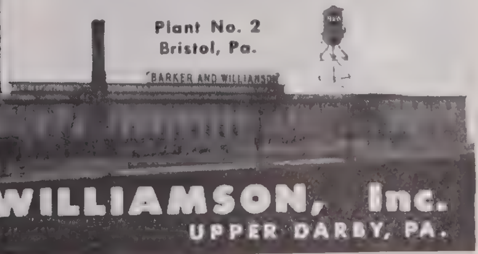
NEY GOLD

THE J. M. NEY COMPANY
171 ELM STREET • HARTFORD 1, CONNECTICUT

150,000 SQUARE FEET
Equipped and Ready for Your Production!

If you need anything electronic, you'll find B&W fully capable of designing and manufacturing it to your most exacting specifications. Three completely equipped, competently staffed B&W plants are ready to go to work on any requirement ranging from a stamped metal part or a coil to a complete transmitter or a complex piece of test equipment.

B&W facilities include ample production space and facilities, a tool room, a machine shop with all machines for drilling, milling, turning, stamping and forming metals and plastics, and a complete woodworking shop. A competent production and engineering staff is available—prepared to use these facilities to best advantage on your requirements. Your inquiries are invited. Write Dept. PR-128 for prompt reply.

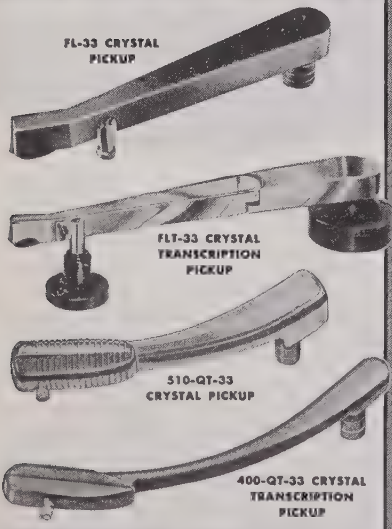


BARKER & WILLIAMSON, Inc.
237 FAIRFIELD AVENUE UPPER DARBY, PA.

ANNOUNCING...

A COMPLETE LINE OF ASTATIC LONG-PLAYING PICKUPS and CARTRIDGES that includes JUST WHAT YOU'RE LOOKING FOR!

● Want a two-in-one pickup that plays both LP and 78 RPM Records with the simple switching of cartridges . . . so simple that a child can make the change in a few seconds? Or, perhaps you are looking for comparable reproduction quality, with more emphasis on economy? Regardless of whether your requirements point to cartridges employing ceramic elements or magnetic-type units . . . whether you prefer permanent or replaceable needles, metal, sapphire or diamond . . . whether cost is first or secondary . . . whatever the conditions to be met —there now is a unit of Astatic precision engineering and construction that will exactly fill the bill. Space permits mention here of only a few. Why not write for new brochure, giving complete information, illustrations, on the Astatic Long-Playing Equipment Line?


FL-33 CRYSTAL PICKUP
FLT-33 CRYSTAL TRANSCRIPTION PICKUP
510-QT-33 CRYSTAL PICKUP
400-QT-33 CRYSTAL TRANSCRIPTION PICKUP

Listed in the Radio Industry Red Book

FL-33 CRYSTAL PICKUP—Incomparable reproduction, utility and convenience. Employs LP-33 Crystal Cartridge for LP Records and LP-78 Crystal Cartridge for 78 RPM Records. Change cartridges in a second, like slipping modern fountain pen from its cap, nothing else to do. Special anti-resonance base mounting.

FLT-33 CRYSTAL TRANSCRIPTION PICKUP—Like the FL-33 Arm, plays either LP or 78 RPM Transcriptions with the LP-33 and LP-78 Cartridges. Anti-resonance base and arm-rest are adjustable to desired height. Five-gram needle pressure and perfect tracking assured by revolutionary hinged division of arm. Two-toned black and satin chrome finish.

FLT-TR CRYSTAL TRANSCRIPTION ARM—The same fine instrument as the FLT-33, except for 2.4 mill tip-radius needle necessary for lateral broadcast transcriptions. Employs the LP-TR Cartridge, instantly replaceable with LP-33 or LP-78 Cartridges.

510-QT-33 CRYSTAL PICKUP—Short mounting centers, gracefully curved lines and moderately offset head make this the ideal pickup for a host of applications. Famous "QT" Series Cartridge with replaceable, one mill tip-radius, precious metal or sapphire needle.

510-MI-2M-33 MAGNETO-INDUCTION PICKUP—Same as 510-QT-33, except for revolutionary Magneto-Induction Cartridge. Consistent service and adverse climatic conditions are no threat to the stability and troublefree operation of this magnetic type unit.

400-QT-33 CRYSTAL TRANSCRIPTION PICKUP—Graceful, slender-lined beauty of professional pickups. Employs QT Cartridge with replaceable precious metal or sapphire needle. Flawless reproduction at lower cost.

400-MI-2M-33 MAGNETO-INDUCTION TRANSCRIPTION PICKUP—Identical to 400-QT-33, except for Magneto-Induction Cartridge.

THE Astatic CORPORATION
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD. TORONTO ONTARIO

Astatic Crystal Devices Manufactured Under Brush Development Co. Patents

Positions Wanted

(Continued from page 55A)

vertisements, displays, sales aids, technical literature. Desires connection as advertising manager or assistant sales manager for medium sized New York City area electrical concern. Box 200 W.

JUNIOR ENGINEER

R.C.A. Institute graduate desires position in production, design or allied fields in New York City vicinity. Age 27. Married. 1 year laboratory and 2 years flight (radio) experience. First class radiotelephone license. Call Da. 6-7203 or write Box 201 W.

TELEVISION ENGINEER

B.S.T.E. Age. 25. Married. First class radiotelephone license. Desires position in television station or development work. Trained in operation and maintenance of R.C.A. Image Orthicon, DuMont equipment and very high frequency techniques. Box 205 W.

JUNIOR ENGINEER

Graduate 2 year course television engineering. Married. Age 25. First class FCC license. Trained in all phases of television studio work. Desires position in television broadcasting field. Box 206 W.

JUNIOR ENGINEER

Syracuse University. B.E.E. June 1948. Age 26. Married with no children. Desires work with power company or motor manufacturing company located in the east. Prefer training program if possible. Interested in transmission and mathematical design. Box 207 W.

ENGINEER

University of Minnesota, communications major. B.E.E. with distinction, August 1948. 2½ years electronics experience in U.S. Army. Desires position in production or electronic development. Will work anywhere in U.S. Box 208 W.

ELECTRONICS ENGINEER

Will graduate March 1949 Iowa State College B.S.E.E. in communications. Married. Age 25. First class Radio Telephone license. Some servicing experience. Desires position in radio or electronics anywhere in U.S. Box 209 W.

ENGINEER

B.S.E.E. Northeastern University, Boston 1947. Two years experience as Navy radio technician with Navy radar and communication equipments. Valuable experience in UHF antenna and radiation research and development at Naval Air Test Center, Patuxent River, Maryland. Desires position in research and design of antennae. Box 210 W.

JUNIOR ENGINEER

B.S. Television Engineering, American Television Institute of Technology, January 1949. Age 25. Married, no children. Three years experience on Navy radar. Desires position in microwave research. Anywhere in U.S. Box 211 W.

JUNIOR ENGINEER

R.C.A. Institute's graduate seeks position in research and development, or production field in New York area. Age 29. Married. Studying for engineering degree at night. Air Force officer, 2½ years experience as instructor in bomb-sight and auto-pilot theory and operation. Box 212 W.

30 MC I.F. STRIPS

Overall gain: 25 db or more.
Bandwidth: 4 plus or minus .4 mc @ 3 db down.
Center freq: 30 plus or minus .5 mc.
Current drain: 30 plus or minus 5 ma.
New, less tubes $17.50

MICROWAVE PLUMBING

10 CENTIMETER

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated $45.00

10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or d.c. arranged switching motor. Mfg. Raytheon. CRP 24AAS New and complete $150.00

10 CM. END-FIRE ARRAY POLYRODS ...$1.75 ea.

"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output $3.00

721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50

10 CM. McNALLY CAVITY Type SG $3.50

WAVEGUIDE SECTION. MC 445A, rt. angle bend, 5½ ft. OA. 8" slotted section $21.00

10 CM. OSC. PICKUP LOOP, with male Homedell output $2.00

10 CM. DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fitting $4.50

10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola $8.00

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00

SHORT RIGHT ANGLE bend, with pressurizing nipple $3.00

RIGID COAX to flex coax connector $3.50

STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00

RT. ANGLES FOR ABOVE $2.50

⅞" COAX. ROTARY JOINT $8.00

RT. ANGLE BEND 15" L. OA $3.50

FLEXIBLE SECTION, 15" L. Male to female .$4.25

MAGNETRON COUPLING to ⅞" rigid coax with TR pickup loop, gold plated $7.50

⅞" RIGID COAX—¼" I.C.

⅞" RIGID COAX, BEAD SUPPORTED per ft. $1.20

SHORT RIGHT ANGLE BEND $2.50

ROTATING JOINT, with deck mounting $6.00

RIGID COAX slotted section CU-60/AP..........$5.00

3 CENTIMETER PLUMBING

(STD. 1" x ½" GUIDE, UNLESS OTHERWISE SPECIFIED)

"X" Band pressurizing gauge section, with 15-lbs. gauge and pressurizing nipple $18.50

45 DEG. TWIST, 6" Long $10.00

12" SECTION, 45 deg. twist, 90 deg. bend $6.00

11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy construction, silver plated $4.50

15 DEG. BEND, 10" choke to cover $4.50

5 FT. SECTIONS, choke to cover $14.50

18" FLEXIBLE SECTION $17.50

"E" and "H" PLANE BEND $12.50

BULKHEAD FEED THRU $15.00

"X" BAND WAVEGUIDE, 1¼" x ⅝" OD, 1/16" wall, aluminum ....per ft. $ .75

WAVEGUIDE, 1" x ½" I.D. per ft. $1.50

TR CAVITY for 724-A TR tube $3.50

3" FLEX SECTION, square flange to circular flange adapter $7.50

724 TR tube (41-TR-1) $2.50

WAVEGUIDE SECTION, CG 251/APS-15A, 26" long choke to cover, with 180 deg. bend of 2½" rad. at one end $6.00

SWR MEAS. SECTION, 4" L, with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00

ROTARY JOINT with slotted section and type "N" output pickup $8.50

WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2½" radius, 90 deg. bend $4.50

SLUG, TUNER/ATTENUATOR, W.E. guide, gold plated $6.50

TR/ATR DUPLEXER section with iris flange ..$8.00

TWIST 90 deg., 5" choke to cover, w/press nipple $6.50

WAVEGUIDE SECTIONS 2½ ft. long, silver plated, with choke flange $5.75

WAVEGUIDE, 90 deg. bend E plane, 18" long ..$4.00

ROTARY JOINT, choke to choke $6.00

ROTARY JOINT, choke to choke, with deck mounting $6.00

S-CURVE WAVEGUIDE, 8" long cover to choke $3.50

DUPLEXER SECTION for 1B24 ....$10.00

CIRCULAR CHOKE FLANGES, solid brass .... .55

SQ. FLANGES, FLAT BRASS ....ea. .55

APS-10 TR/ATR DUPLEXER section with additional iris flange $10.00

CU 105/APS 31 Directional coupler, 25 db $15.00

CU 106/APS 33 Directional coupler, 25 db $15.00

CG 176/AP Directional coupler, 20 db $18.00

FLEX. WAVEGUIDE ....$4.00/Ft.

"X" BAND calibrated attenuator $85.00

SHIELDED KLYSTRON tube mounts with rough attenuator outputs $90.00

2½" FLEXIBLE SECTION, cover to cover $5.00

SHORT ARM "T" section, with additional choke output on vertical section $4.00

COAX CABLE

RG 18/U. 52 ohm im. armored ....$ .51/ft.

RG 23/U. twin coax, 125 ohm imp. armored ..$ .50/ft.

RG 28/U. 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV ....$ .50/ft.

RG 35/U, 70 ohm imp. armored ....$ .50/ft.

1.25 CENTIMETER

MITRED ELBOW cover to cover $4.00

TR/ATR SECTION choke to cover $4.00

FLEXIBLE SECTION 1" choke to choke $5.00

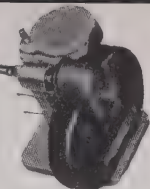
KBAND Rotary joint $45.00

ADAPTER, rd. cover to sq. cover $5.00

MITRED ELBOW and S sections choke to cover .$4.50

AN/CPN-6, 3 CM RADAR BEACON INSTALLATIONS

MAGNETRONS



2J41 Magnetron-Magnet-Stabilizer Pkg. 9290-9330MC, 1.25 KW Pk. Pulse Output Power. 100MC Tuning Range. Refer Rad. Lab. Series Vol. 6, Pg. 766 ....(as shown) $75.00

TUBE	FRQ. RANGE PK.	PWR. OUT	PRICE
2J31	2820-2860 mc.	265 KW.	$25.00
2J21-A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$25.00
2J26	2992-3019 mc.	275 KW.	$25.00
2J27	2965-2992 mc.	275 KW.	$25.00
2J32	2780-2820 mc.	285 KW.	$25.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267-3333 mc.	87 KW.	$25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	$25.00
2J61	3000-3100 mc.	35 KW.	$65.00
2J62	2914-3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	50 KW.	$55.00
5J30			$39.50
714AY			$25.00
718DY			$25.00
720BY	2800 mc.	1000 KW.	$50.00
720CY			$50.00
725-A	9345-9405 mc.	50 KW.	$25.00
730-A	9345-9405 mc.	50 KW.	$25.00

Klystrons: 723A/B $12.50 707B W/Cavity $20.00

MAGNETS

For 2J21, 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31 ....Each $8.00

4850 Gauss, ⅝" bet. pole faces, ¾" pole diam. $8.00

1500 Gauss, 1⅛" bet. pole faces, 1⅝" pole diam. $8.00

TUNABLE PKGD. "CW" MAGNETRONS

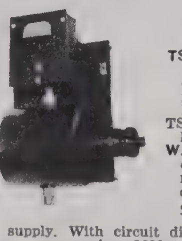
QK 61	2975-3200 mc.	QK 62	3150-3375 mc.
QK 60	2800-3025 mc.	QK 59	2675-2900 mc.

New, Guaranteed ....Each $65.00

GREAT TUBE VALUES

01-A	$ .45	5FP7	3.50	532	3.95	1629	.35
1B24	4.85	5JP2	8.00	559	4.00	1961	5.00
1H5	.55	5J30	$39.50	562	90.00	8012	3.95
1N5	.69	6AC7	1.00	615	.89	9002	.65
1T4	.69	6G	2.00	703-A	7.00	9004	.47
2C21	.69	6K7	.55	704-A	.75	9006	.47
2C22	.69	6L6GA	1.00	705-A	2.85	CEQ 72	1.95
2J21-A	25.00	6SC7	.70	†707-B	20.00	EF 50	.79
2J22	25.00	6SL7	1.00	714AY	25.00	F-127	20.00
2J26	25.00	6V6	.79	715-B	12.00	FC 258A	
2J27	25.00	7C4	1.00	720BY	50.00		165.00
2J31	25.00	7E5	1.00	720CY	50.00	FC 271	40.00
2J32	25.00	10Y	.60	721-A	3.60	GL 562	75.00
2J38	25.00	12A6	.35	723-A/B		GL 623	75.00
2J39	25.00	12GP7	14.95		12.50	GL 697	75.00
2J55	25.00	12K8Y	.65	724B	1.75	ML 100	60.00
3J31	55.00	12SF7	.49	725-A	25.00	QK 59	65.00
2X2/879	.69	12SR7	.72	726-A	15.00	QK 60	65.00
3A4	.65	15R	1.40	800	2.25	QK 61	65.00
3BP1	2.25	28D7	.75	801-A	1.10	QK 62	65.00
3C24	.60	30 (Spec.)		804	9.95	*RCA932	.65
3C30	.70		.70	815	2.50	VR 91	1.00
3D6	.79	45 (Spec.)		836	1.15	VR 130	1.25
3CP1/S1	3.50		.59	837	1.95	VR 135	1.25
3D21-A	1.50	39/44	.49	843	.59	VR 137	1.25
3DP1	2.25	35/51	.72	860	15.00	VU 120	1.00
3EPI	2.95	227A	3.85	861	40.00	VU 134	1.00
3FP7	1.20	225	8.80	874	1.95	WL 532	4.75
3GP1	3.50	268-A	20.00	876	4.95	WN 150	3.00
3Q5	.79	355-A	19.50	1005	.35	WT 260	5.00
5BP1	1.20	417A	22.50	1613	.95	†with cavity	
5BP4	4.95	530	$90.00	1619	.21		5.00
5CP1	3.75	531	45.00	1624	$ .85	*Photocell	

MICROWAVE TEST EQUIPMENT



TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity. 2700 to 2900 Mcs calibrated ...$85.00

TS 108-AP dummy load $65.00

W. E. I 138. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00

3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges $15.00

3 cm. stabilizer cavity, transmission type ..$20.00

3 cm. **Wavemeter, Micrometer** head mounted on X-Band guide. Freq. range approx, 7900 to 10,000 Mc. $75.00

COAX CONNECTORS

831SP	$.35	**UG 254/U**	$.75
831AP	$.35	**UG 255/U**	$1.25
831HP	$.15	**UG 146/U**	$1.00
UG 21/U	$.85	**UG 85/U**	$1.25
UG 86 U	$.95		

Homedell male to type "N" male adapter $1.25

D-166366 Baby "N" ....$ .85

Adapter Cable Ass'y, Type "N" Male to Type "N" Female $2.25

Adapter Cable Ass'y, Sperry Male to Type "N" Male $2.25

Connector, ‡49579 for RG 18/U $1.80

VARISTORS W.E.

D-171121	$.95	D-168549	$.95
D-171631	$.95	D-162482	$3.00
D-167176	$.95	D-99136	$1.65
D-168687	$.95	D-166271	$2.50
D-171812	$.95	D-162356	$1.50
D-171528	$.95	D-161871A	$2.85
D-163298	$.95	D-99946	$2.00

THERMISTORS—W.E.

D-167332 (tube)	$.95	D-164699 FOR MTG. in "X" Band Guide	$2.50
D-170396 (bead)	$.95	D-167018 (tube)	$.95
D-167613 (button)	$.95		
D-166228 (button)	$.95		

MICROWAVE GENERATORS

AN/APS-15A "X" Band compl RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc & beacon), 1B24 TR, revr-ampl, duplexer, HV supply, blower, pulse xfmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec apx. 13 KV Pk Pulse. Compl with all tubes incl. 715-B. 829B. RKR 73, two 72's. Compl pkg, new $210.00

APS-15B. Complete pkg. as above, less modulator $150.00

PULSE EQUIPMENT

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS. Sweep time: 100 to 2,500 microsec. in 4 steps, fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac, 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a signal generator such as General Radio ‡804B or ‡804C used in depot bench testing of SCR 695, SCR 595, and SCR 535, New $125.00

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 114 KW (12 KV at 12 amp). Duty Ratio: .001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715-B, 1-829-B, 3-'72's, 1-'73. New $110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk); pulse rate 200 PPS, 1.5 microsec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-10 MODULATOR DECK, Complete, less tubes $75.00

APS-10 Low voltage power supply, less tubes ..$18.50

PULSE NETWORKS

G.E. ‡25E5-1-350-50P2T, 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 ohms impedance $45.00

G.E. ‡6E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance $6.50

G.E. ‡3E (3-.84-810; 8-2.24-405) 50P4T: 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections, .84 Microsec, 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 Microsec, 40 PPS, 50 ohms imp. $6.50

PULSE TRANSFORMERS

W.E. ‡D166173 HI-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc, 2 sections parallel connected, potted in oil $12.00

W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $2.00

G.E. ‡K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK, Sec. Output: 28 KV PK. Peak Output: 800 KW. Bifilar 2.75 Amp. $19.50

W.E. ‡D169271 Hi Volt input pulse Transformer..$9.95

G.E. K2450A Will receive 13KV. 4 micro-second pulse on pri, secondary delivers 14KV. Peak power out 100KW GE $15.00

G.E. ‡K2748A Pulse Input, line to magnetron ..$12.00

‡9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32 ....$1.50

PE218 INVERTERS

Input: 25-28 VDC @ 92 amps. Output: 115 volts @ 1500 volt-amps. 380-500 cycles. New, Hermetically Sealed $49.95

MICROWAVE ANTENNAS

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00) $250.00

APS-4 3 cm. antenna. Complete. 14½" dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete ..$65.00

AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases $89.50

RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4½' x 3', rectangle, new $85.00

TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New $100.00

SO-13 ANTENNA, 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn.
New .... $120.00 Used $45.00

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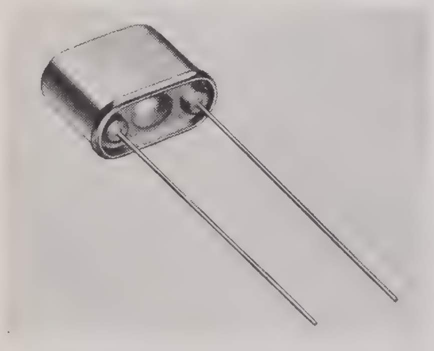

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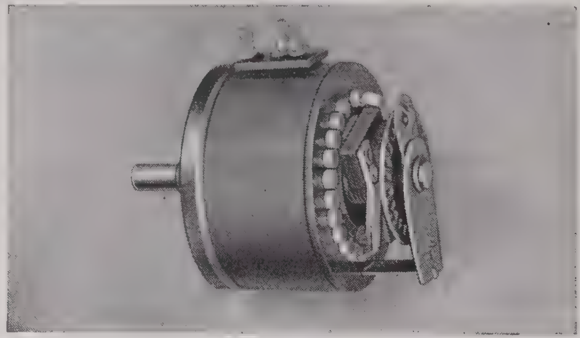
Shallcross ATTENUATORS



BRIDGED 'T' ATTENUATOR

Type 410-4B1

10 steps, 4 db/step. Linear attenuation with detent. 2⅛" diameter, 2 1/16" depth.

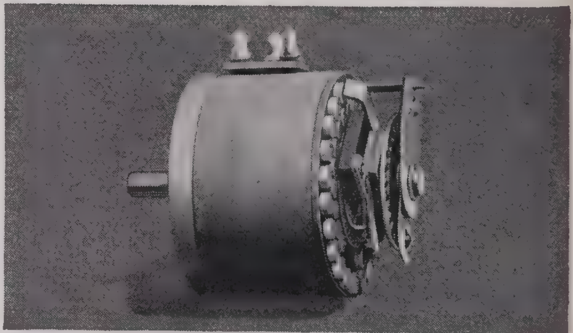
$11.50
LIST PRICE

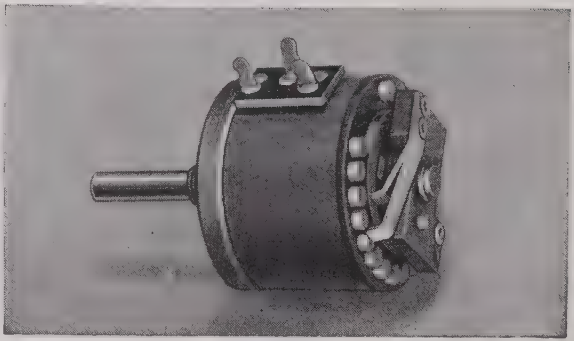
BRIDGED 'T' ATTENUATOR

Type 420-2B2

20 steps, 2 db/step. Linear attenuation with off position and detent. 2⅛" diameter, 2 1/16" depth.

$16.00
LIST PRICE





POTENTIOMETER

Type C720-2A3

20 steps, 2 db/step, tapered on last three steps to off, composition resistors. 1¾" diameter, 1¾" depth.

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These Shallcross Features Mean Better Performance —Better Value!

Off position attenuation well in excess of 100 db.

25% to 50% fewer soldered joints.

Noise level ratings that are factual. (130 db. or more below zero level.)

Non-inductive Shallcross precision resistors used throughout assure flat attenuation to and beyond 30 kc.

Types and sizes engineered for all needs. Attentuation accuracies of 1%, Resistor accuracies of 0.1%, on special order.

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Shallcross variable attenuators have proved their remarkable quietness and serviceability in dozens of applications for leading users in all parts of the world. Such important details as the use of spring-temper silver alloy wiper arms, silver alloy collector rings and contacts, non-inductive precision resistors, and sturdy, substantial mounting plates have made possible the high standard of performance attributed to Shallcross.

Standard types include ladder and bridged T mixer controls, bridged T and straight T master gain controls and V.U. meter multipliers, wirewound and composition potentiometers for grid control. Cueing attenuators, and fixed pads, both composition and wirewound, in all circuit configurations are also available.

Write for Catalog and Attenuator Specification Sheet

SHALLCROSS MANUFACTURING COMPANY

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Kahle Engineering Co.	65A
James Knights Co.	58A
Lavoie Labs.	31A
Linde Air Products	26A
Machlett Laboratories	28A & 29A
P. R. Mallory & Co., Inc.	19A
Marion Electrical Inst. Co.	25A
W. L. Maxson Corp.	52A
Measurements Corp.	66A
Melpar, Inc.	52A
Eugene Mittelmann	62A
Mycalex Corp. of America	36A & 37A
National Union Radio Corp.	50A
Newark Electric Co.	65A
J. M. Ney Co.	55A
North American Philips Co., Inc.	43A
Ohmite Mfg. Co.	24A
Panoramic Radio Corp.	67A
Par Metal Products Corp.	61A
Philco Corp.	50A
Presto Recording Corp.	15A
Radio Corp. of America	32A, 51A, 68A
Reeves-Hoffman Corp.	40A
Revere Copper & Brass, Inc.	16A
Paul Rosenberg Associates	62A
A. J. Sanial	62A
Shallcross Mfg. Co.	58A
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Sola Electric Co.	13A
Sorensen & Co., Inc.	20A
Sperry Gyroscope Co., Inc.	52A
Sprague Electric Co.	12A
Stackpole Carbon Co.	8A
Superior Electric	66A & 67A
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Taylor Fibre Co.	21A
Tech Labs., Inc.	63A
Technical Materiel Corp.	62A
Technology Instrument Corp.	62A
Tektronix, Inc.	63A
Transradio, Ltd.	59A
Truscon Steel Co.	46A
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Western Electric Co.	2A & 3A, 35A
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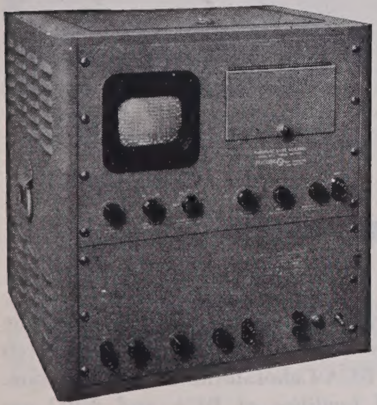

- Indications are spectrographic-frequency versus voltage
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- Tedious, point by point frequency checks are eliminated
- Observations of random changes in energy distribution are possible
- Chances of missing components are removed
- Operation is simple
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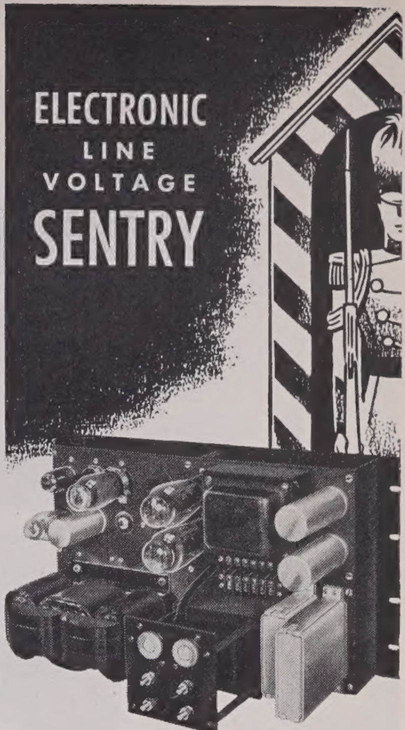

Rear View STABILINE Type IE

The Superior Electric STABILINE Automatic Voltage Regulator acts as a sentry — always "on duty" to maintain a constant voltage to electrical apparatus. Type IE, an *all-electronic* regulator, acts instantaneously to keep delivered voltage to within ±0.1 volts of the preset value, regardless of line variations. STABILINE Type IE will hold the output to within ±0.15 volts for any load current change or load power factor change from lagging .5 to leading .9. Waveform distortion never exceeds 3 percent — a negligible error not recognized in instrument readings.

Bulletin 547 gives you information on this and other Superior Electric voltage control equipment. Write for your copy today.

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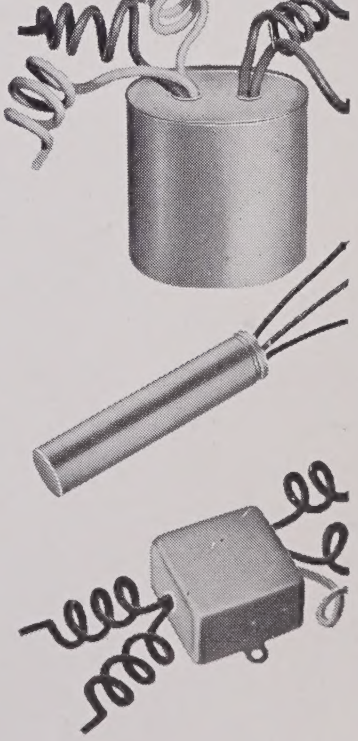

You may build the best appliance of its kind on the market — but if it sets up local radio interference—you'll have tough sledding against today's keen competition. Your customers are *demanding* radio noise-free performance in the electrical equipment they buy.

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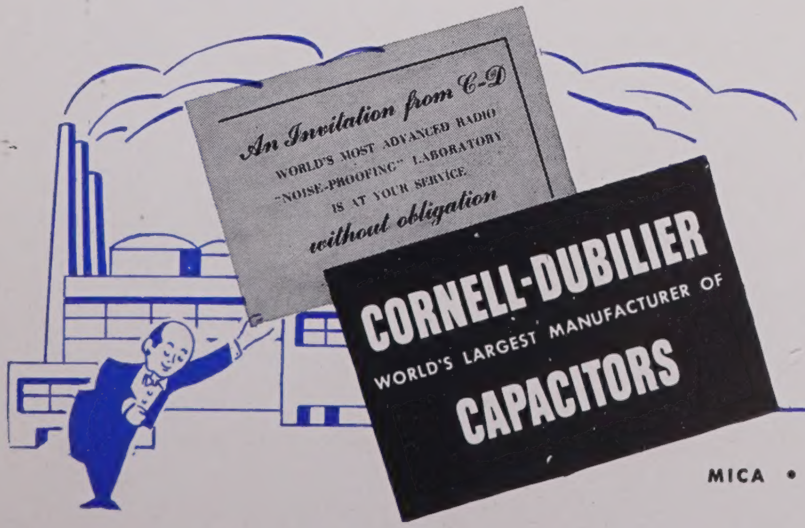
Make Your Product More Saleable with C-D Quietone Radio Noise Filters and Spark Suppressors



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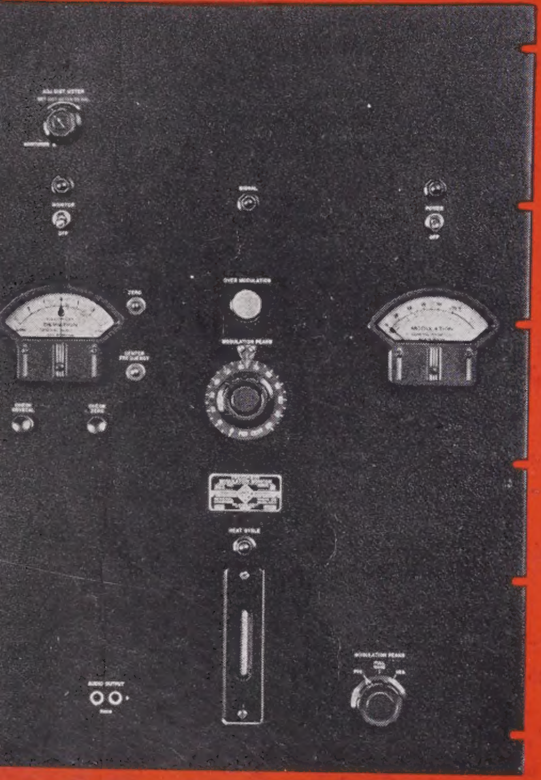
COMPLETE MONITORING EQUIPMENT By

for TV and FM TRANSMITTERS



WITH our recent announcement of the Type 1182-T Video Frequency Monitor, complete transmitter monitoring equipment by General Radio Company for TV as well as FM stations is now available. The FM Monitor has FCC approval; the TV equipment meets all of the tentative proposed specifications of the FCC.

Simple to install, practically self-explanatory in operation, direct-reading in frequency deviation, these monitors have the same high accuracy and stability and years of reliable operation ahead of them that all G-R broadcast monitoring instruments have provided since the beginning of broadcasting.

This equipment can be bought with confidence . . . confidence that it will give trouble-free operation with the minimum of routine maintenance. The G-R trade mark insures that.

TYPE 1170-A FM MONITOR

For both FM and audio channel monitoring of TV stations, features: **TRANSMITTER RANGES** of either 30 to 162 Mc or 160 to 220 Mc. **CONTINUOUS MONITORING:** center-frequency indication continuous; requires restandardization only once a day. **REMOTE MONITORING:** equipped with circuits and terminals for remote indicators of Center-Frequency Indication, Percentage-Modulation Meters, Over-Modulation Lamp, 600-Ohm Unbalanced Aural Monitor, Recorder and with the Type 1932-A Distortion and Noise Meter will measure distortion. **HIGH STABILITY:** 200 cycles (2 parts per million) or better with daily check of electrical zero of meter. **LOW INPUT POWER:** 1 volt at high impedance, amplified to several hundred volts for high-level operation. **LOW RESIDUAL DISTORTION:** less than 0.2% at 100 k.c. swing; accurate for measurements to as low as ½ per cent. **75-25 KC DEVIATION** provided with a single internal adjustment for either TV or FM monitoring. **TYPE 1170-A FM MONITOR . . . $1625**

TYPE 1182-T VIDEO MONITOR

For video channels of TV transmitters, features include: **TRANSMITTER RANGE:** 54 to 220 Mc. **DEVIATION RANGE:** 3-0-3 and 6-0-6 kc for all present TV channels. **DEVIATION** from assigned channel is shown continuously on large-scale meter, unaffected by TV video modulation. **HIGH STABILITY:** ± 0.001%. **HIGH ACCURACY:** crystal frequency when monitor is delivered is within ± 0.001% (10 parts per million). Adjustment provided to set monitor in agreement with frequency measuring service. **HIGH IMPEDANCE INPUT CIRCUIT** for channels 2 to 6; coaxial line for channels 7 to 13. **REMOTE FREQUENCY DEVIATION METER** terminals provided. **THREE SPARE CRYSTAL POSITIONS** selected by panel switch. **TYPE 1182-T VIDEO FREQUENCY MONITOR . . . $675**

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